MAINTENANCE AND OPERATION MANUAL

MODEL M-14 (No.1½) & M-18 (No.3)

MOORE UNIVERSAL MEASURING MACHINE

IMPORTANT: Read carefully before assembling machine. Keep for ready reference.

INFORMATION REQUIRED WHEN ORDERING REPLACEMENT PARTS

We suggest the following information essential for prompt service on replacement part orders:

IMPORTANT

1. Serial Number of machine
2. Model number of machine
3. Part number and/or item number
4. Name of part
5. Quantity of part required

The Serial Number of the machine is important in order that we may check and be certain that we are furnishing the properly designed part to fit your machine.

P.O. NO._____

MACH. NO._____

WIRED FOR_____VOLTS

_____CYCLE,_____PHASE

Moore Special Tool Co., Inc.

800 Union Avenue

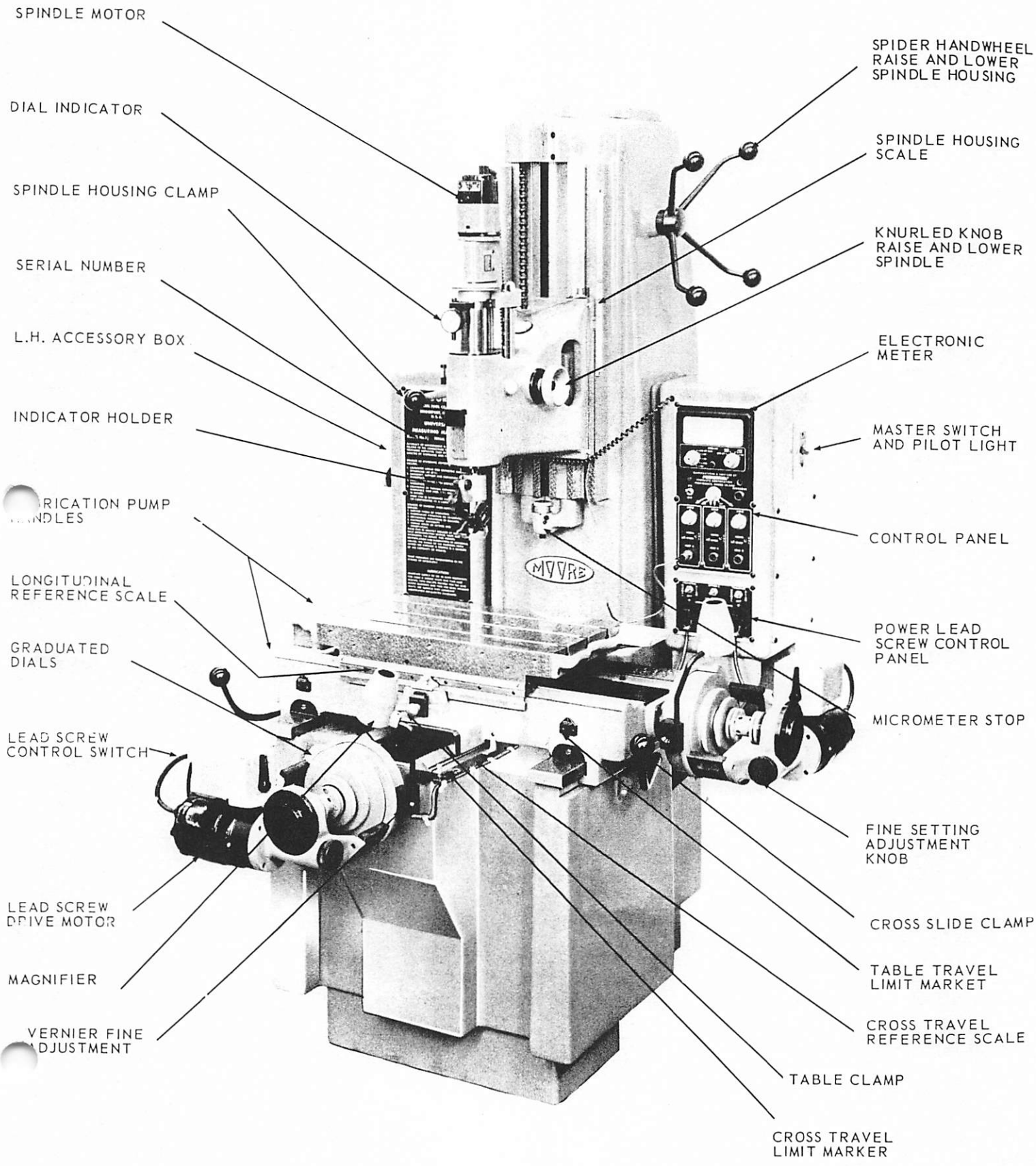
Bridgeport, Connecticut 06607

Tel: 366-3224 (Area Code—203)

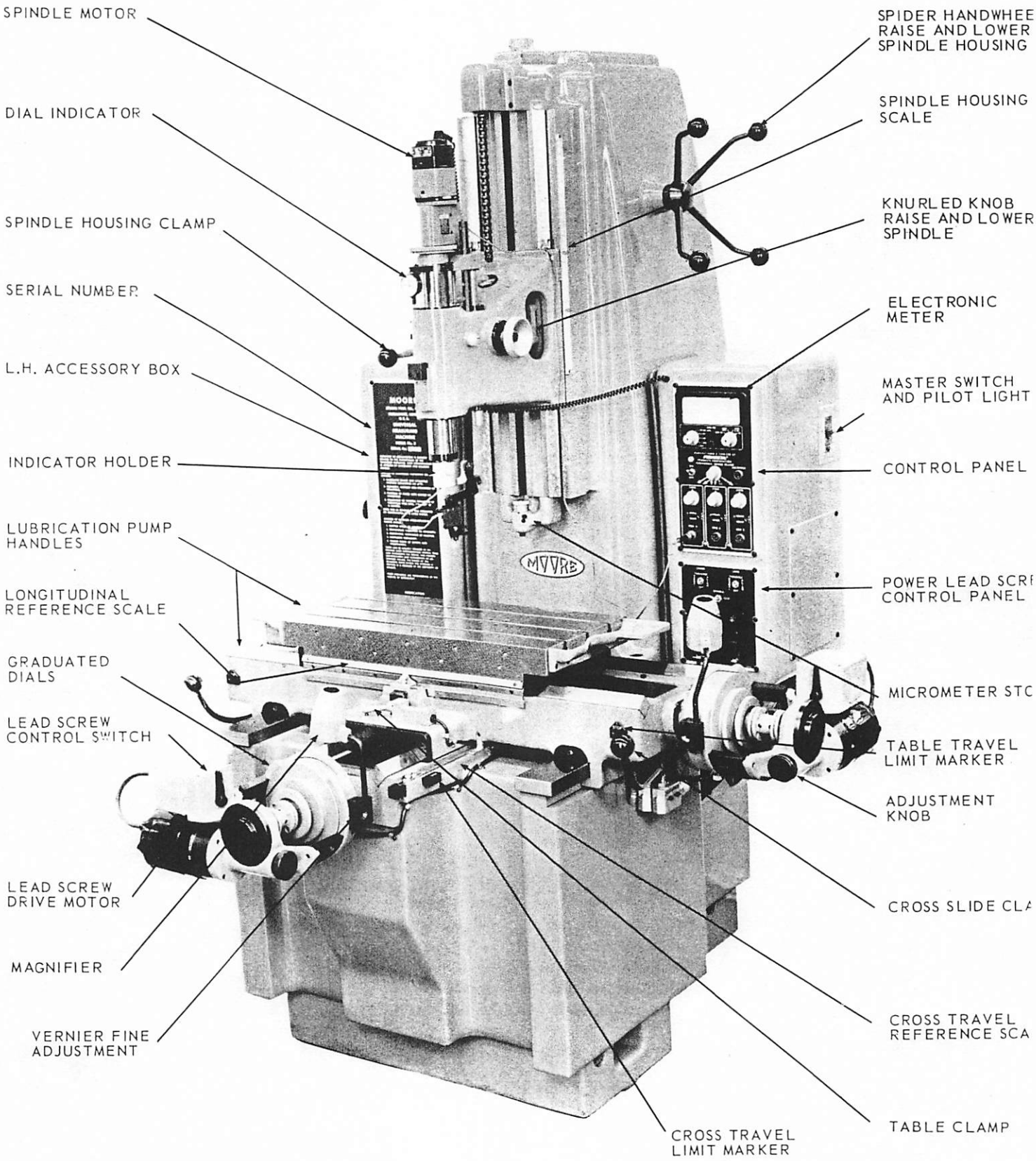
TABLE OF CONTENTS

	PAGE
GENERAL INFORMATION	
INSTALLATION	
Location	3
Setting Up	3
Leveling	3
Wiring	3
MAINTENANCE	
Lubrication	3
Cleaning	4
Lead Screw Backlash	4
CONTROLS	
Table Positioning	4
Housing Positioning	4
Quill Positioning	5
Spindle Rotation	5
Electronic Gage	5
Microscope	6
Polar Recorder	8
Strip Recorder	8
Principles of Electronic Gage Measurement	9-11
PARTS LIST – DRAWINGS	
Measuring Machine Major Assembly – Outline & Foundation Layout	13-16
Column Assembly	17-20
Spindle Housing	21-24
R.H. & L.H. Sub-Assembly	25-26
Counterweight Sub-Assembly	27
Sprocket Housing Sub-Assembly	28
Friction Clutch Assembly	28
Micrometer Stop Assembly	29
Spider Sub-Assembly	29
Travel Stop Assembly	30
Magnifier Sub-Assembly	30
Indicator Mount Assemblies	31
Limit Stop Installation	31-32
Schematic Diagram (without drive)	33
Fan Sub-Assembly	33
Electrical Installation	34
Base, Table, and Cross Slide Assembly	35-38
Cross Slide & Table Lead Screw Sub-Assembly	39-40
Table & Cross Slide Bijur Lubricating System Assembly	41-44
Wiring Diagram Electrical Controls (with L.S. Drive)	45
Switch Sub-Assembly	46
Traverse Panel Sub-Assembly	47
Lead Screw Drives	48
Limit & Clamp Switches	49
Drive Panel Sub-Assembly	49
Electrical Installation	50
Power Feed Control Installation	51-52
Transparent Stage Assembly	53
Collimated Light Assembly	53
Floor Plan Layout	54
Federal Amplifier	55-58
Cleveland Amplifier	59-62

MODEL 1½


SPINDLE MOTOR
DIAL INDICATOR
SPINDLE HOUSING CLAMP
SERIAL NUMBER
L.H. ACCESSORY BOX
INDICATOR HOLDER
RICATION PUMP
NDLES
LONGITUDINAL REFERENCE SCALE
GRADUATED DIALS
LEAD SCREW CONTROL SWITCH
LEAD SCREW DRIVE MOTOR
MAGNIFIER
VERNIER FINE ADJUSTMENT
SPIDER HANDWHEEL RAISE AND LOWER SPINDLE HOUSING
SPINDLE HOUSING SCALE
KNURLED KNOB RAISE AND LOWER SPINDLE
ELECTRONIC METER
MASTER SWITCH AND PILOT LIGHT
CONTROL PANEL
POWER LEAD SCREW CONTROL PANEL
MICROMETER STOP
FINE SETTING ADJUSTMENT KNOB
CROSS SLIDE CLAMP
TABLE TRAVEL LIMIT MARKET
CROSS TRAVEL REFERENCE SCALE
TABLE CLAMP
CROSS TRAVEL LIMIT MARKER
MOORE

MODEL 3


SPINDLE MOTOR
DIAL INDICATOR
SPINDLE HOUSING CLAMP
SERIAL NUMBER
L.H. ACCESSORY BOX
INDICATOR HOLDER
LUBRICATION PUMP HANDLES
LONGITUDINAL REFERENCE SCALE
GRADUATED DIALS
LEAD SCREW CONTROL SWITCH
LEAD SCREW DRIVE MOTOR
MAGNIFIER
VERNIER FINE ADJUSTMENT
SPIDER HANDWHEE RAISE AND LOWER SPINDLE HOUSING
SPINDLE HOUSING SCALE
KNURLED KNOB RAISE AND LOWER SPINDLE
ELECTRONIC METER
MASTER SWITCH AND PILOT LIGHT
CONTROL PANEL
POWER LEAD SCRE CONTROL PANEL
MICROMETER STO
TABLE TRAVEL LIMIT MARKER
ADJUSTMENT KNOB
CROSS SLIDE CLA
CROSS TRAVEL REFERENCE SCA
TABLE CLAMP
CROSS TRAVEL LIMIT MARKER
MOORE

INSTALLATION

LOCATION

It is highly desirable to choose the location for setting up the machine with great care. Factors to be considered are:

1. Temperature conditions
2. Cleanliness
3. Absence of vibration
4. Rigidity of mounting floor

It is obvious that temperature is a vitally important factor where any precise measurement is to be made, regardless of the equipment or method.

It is entirely practical to measure with satisfactory accuracy in an area which, while not temperature controlled, has a reasonably constant temperature and is free from drafts.

Under no conditions should the machine be so located that direct sunlight falls on or near it, nor should it be placed close to a heat source such as a radiator.

A more desirable location would be in a temperature controlled area maintained at a comfortable level. Under these conditions it is practical to arithmetically correct measurements made on non-ferrous parts to compensate for their differences of thermal expansion. In general, this need be considered necessary only when measurements to the highest possible order of accuracy over considerable length is required.

Ideally, however, all ultra-precise measurements, particularly of longer lengths and with materials having dissimilar coefficients of thermal expansion, should be made at 68° F. This is the internationally accepted temperature at which all standards measurements are made and at which, for example equivalent gage blocks of steel, tungsten carbide, or chrome carbide would agree in length and could be used to measure an aluminum workpiece directly. The same principle holds true in the relation of the measuring machine lead screws to workpieces of various materials.

Cleanliness of the location is important inasmuch as dust and dirt can easily cause errors in measurement, not by its effect on the machine, but by introducing error in pickup of the workpiece. Should the machine be located in a temperature controlled area it is desirable to introduce filters of either the mesh or ionization type into the air circulating system.

Vibration, though not a serious problem could possibly create difficulty in meter readings, particularly at higher amplifications. If this condition does exist, mounting the machine on the three isomode pads provided will absorb the majority of vibrations.

When selecting a location, it is essential that a rigid floor be chosen.

SETTING UP

The design and construction of the Universal Measuring Machine is rugged and very capable of withstanding normal handling. Sudden shocks, however, should be avoided as the results may permanently impair the high accuracy of this machine. An eyebolt is provided at the top of the column for use when the machine is to be lifted by an overhead crane; care should be taken, however, that lifting is done slowly and smoothly.

The cleaning of ways and spindle and the removal of any shipping clamps should be carried out by a factory demonstrator.

WARNING: DO NOT UNPACK, CLEAN OR INSTALL THE LEAD SCREWS WHICH ARE SHIPPED IN SEPARATE BOXES WITHIN THE CRATE. THIS WILL BE DONE BY FACTORY DEMONSTRATOR.

LEVELING

To prevent twisting strains being introduced, the machine should be mounted only on the three pads, at the two front corners and center rear. Under no circumstances should the machine be bolted down. The holes in the feet are for shipping purposes only.

If a vibration-free cement foundation is provided, precision leveling can be quickly and efficiently achieved by the use of the three isomode pads.

For installation on a typical shop floor where vibration may be present, the machine may be satisfactorily mounted on pads of dampening material.

WIRING

It is only necessary to plug the cord provided into a 110v. outlet with proper electrical ground to satisfy the electrical requirements of the machine. Master switch and pilot light are on side of R.H. control box.

MAINTENANCE

LUBRICATION

For all Moore machines with oil filled, Leadscrew cavities.

Inspect Leadscrew oil cavities by pushing base and cross slide guards back. Change or add oil to cover Leadscrew when necessary.

Use Mobil Vacuoline Oil 1409, for Jig Borers, Jig Grinders, Measuring Machines and N/C Continuous Path Jig Grinders.

Use Mobil D.T.E. Light Oil for N/C Point to Point Jig Borers and Jig Grinders and N/C Continuous Path Jig Borers.

The lubricators located in the L.H. end of the table and cross slide should be used daily by pulling out knob and allowing it to return. Keep the reservoirs filled with Sunoco Way Lubricant #80. Oilers are loca-

ted in the upper end of the quill housing ways and adjacent to the lead screw zero dials. Fill once a week with Sunoco Way Lubricant.

The small oiler on the front left hand side of the quill housing should be filled when the oil level falls below the sight window with *Velocite No. 6 oil only.* Oiling of racks supporting quill may be done periodically. The spindle itself is lubricated for life and no attempt should be made to oil it.

CLEANING

The accuracy of the machine is best preserved by following a few simple suggestions:

1. Wipe machine ways frequently and re-oil.
2. Once a day run the lead screws the full length of travel, also raise and lower the quill housing the full length of travel.
3. *Never* use an air hose for cleaning purposes.
4. When the machine is not in use for long periods, a cover of thin transparent plastic sheeting is highly recommended. However, care should be taken as staining may occur if the plastic sheeting is left too long.

LEAD SCREW BACKLASH

The necessary backlash between the screw and nut and between the thrust bearing and thrust collar is set at the factory and it is strongly recommended that the latter be adjusted only by dealer or factory service man. Backlash has no functional effect on coordinate positioning provided settings are correctly made in the direction indicated by the arrow on the lead screw zero dial.

CONTROLS

TABLE POSITIONING

Table movement, longitudinal and transverse, is made by means of precision lead screws. These are operated, on the standard machine, by handwheel and read on large dials graduated to 0.0002", read against verniers to 0.00002". As optional equipment, the handwheels may be replaced by a motorized drive.

The dials may be set to approximate zero by releasing the knurled clamp knob #4832 Fig. 41. Final zeroing is most conveniently done by adjustment of the vernier dial by means of the tangent screws on the circumference of the dial housing. To eliminate the effect of backlash, settings should always be made in the direction indicated by the arrows on the zero dials. Always clamp axes immediately after final setting of leadscrew.

The table reference scale, graduated to 0.100", is provided with an adjustable zero bracket to facilitate setting to the nearest whole inch as a starting point. The cross slide reference scale, similarly graduated, is movable in relation to the zero. These scales, in effect, eliminate the need for counting turns of the dial and always show the location of the table.

Positive travel stops are provided with visual stop markers. Care should be taken to avoid hitting the stops sharply.

Machines equipped with motorized lead screws are provided with a three position selector switch which controls each drive unit. In addition to the OFF position, these switches control the traverse speeds of table movement and are located on the front of the right hand control box.

The NORMAL position is used for actual measuring displacement, whereas the ALIGN position is used only to indicate the workpiece for alignment and orientation.

In addition, machines equipped with motorized lead screws are provided with electrical limit switches which will shut off power to units when: 1) full travels are obtained 2) the table is clamped or, 3) the slide unit is clamped. *All clamps must be released for drive units to be operational.*

A switch box is located on each lead screw motorized drive unit. The switch box controls the direction of travel indicated by arrows on the cover of the switch box. Each unit has two speeds in each direction. A pushbutton locking device to hold the switch in a desired traverse speed rate is provided.

Pushed to its extreme position the switch provides the fastest movement permitted by the chosen setting of the selector switch, at which one monitors position by means of the reference scales until close to the required location. At this point the switch is brought back nearer to center which slows up the movement to a degree that numerals on the dial can be read. Just before the desired dial setting is reached the switch is released and power movement stops. Final setting is made by the small knurled knob projecting at right angles to the main dial.

HOUSING POSITIONING

Movement of the quill housing on the column ways is controlled by a spider wheel on the right hand side of the column, first releasing the clamp by raising the handle projecting through the left hand side of the housing. Re-clamping does not require excessive pressure on the clamp handle.

A reference scale with sliding clips provides a convenient point of alignment with the zero plate on the housing to facilitate repeat settings.

The removable micrometer stop at the bottom of the column ways provide a more accurate method of repeating housing settings. The knurled thimble of the micrometer stop is graduated to .001, providing a one inch range. It is possible to obtain any combination of positive stops within eight inches of the total travel of the housing with the various microstop end blocks provided which lock into the "T" slot of the column.

QUILL POSITIONING

Vertical movement of the quill within the housing is accomplished by means of the large knurled knob on the right hand side of the housing. Although the quill is counterbalanced, it would be desirable to unlock and lock the quill clamp knob, #6899, Fig. 21-22, before and after each movement of the quill. The quill clamp knob is located on the left side of the housing.

A graduated, vertical scale for quill positioning projects through the top of the quill housing on the right hand side. This scale can be set, as desired, by means of the small knurled knob directly below it.

For very accurate vertical settings, the use of the mechanical indicator (supplied Fig. 21-22) or one of the electronic type gage heads (listed under accessories) is required. The indicator is mounted on the indicator plate, #4907 Fig. 21-22, By inserting appropriate gage blocks between the lapped plate, #4906 Fig. 21-22, and the indicator depth or vertical measurements may be accurately made.

SPINDLE ROTATION

The knurled locking screw, #6920A, Fig. 21-22, is provided for locking the spindle, therefore preventing any spindle rotation during measurement.

The spindle may be rotated in either direction by the spindle drive motor or by hand. To drive the spindle by the drive motor: 1) release the knurled locking screw 2) shift the four-speed geared motor to the desired speed 3) select direction of rotation at the spindle switch located on the lower front panel of the right hand control box. The spindle switch also controls the power to the spindle drive motor.

To rotate the spindle by hand: 1) release the knurled locking screw 2) shift the drive motor to one of the four neutral positions which appear between the speeds.

The graduated dial at the top of the spindle is graduated every 5° with numerals every 30°. When the spindle is locked, the graduated dial may be turned to line it up with the zero marker provided.

ELECTRONIC GAGE

The electronic gage head is mounted to the holder with a ¼-20 screw. The connector lead is then passed through the I.D. of the holder.

For mounting the assembly to the spindle, turn the spindle in order that the set screw located at the nose of the spindle is facing the front of the machine. Plug the connector up into the spindle nose with the white reference dot located on the connector facing in the same direction as the set screw in the spindle. Mount the gage holder to the spindle by aligning the flat on the spindle nose with the knurled thumb screw on the holder. Lock the holder to the spindle nose by tightening the grey knurled thumb screw. Do not use excessive pressure. At all times care should be exercised when assembling or disassembling this unit to prevent any damage to the spindle.

The electronic gage head is approximately positioned by means of movement of the supporting linkage. A black knurled screw on the latter permits finer adjustments until meter indicates contact between gage tip and workpiece. Final zeroing is most conveniently done by use of the centering knob on the control panel. A small knurled screw head on the side of the gage permits reversal of direction of indication.

A selector switch near the top of the panel permits choice of amplification on the meter. Recorders, polar or strip type, are available as accessories. These units plug into a receptacle on the amplifier panel. Changeover from meter indication to recorder is by means of the switch, so marked on the panel.

While the gage head is ruggedly constructed, it is not immune to damage as a result of rough handling. It is therefore desirable to keep an extra gage head as a spare, thus insuring against machine down time while a damaged head is being repaired by the manufacturer. A holder for a mechanical indicator is provided with the machine, permitting the use of such an instrument in case of emergency.

MICROSCOPE

The microscope, Fig. 1, while not as versatile as the gage, permits pickup of holes too small for the probe tip, measurement of contours such as thread flank angle as well as scale and dial observation. A collimated light source provides the required type of illumination when working with workpieces on the optical stage. In such cases, as well as with screw thread measurement, the light is so placed beneath the work as to shine directly up past the work and into the objective lens of the microscope. In this way a sharply defined image will be produced. Reticle values are shown in Fig. 2.

Mounting the microscope on the spindle nose is accomplished in the same manner as the gage head holders. It is possible to orient the microscope to any radial position convenient for the operator and lock in position by using spindle lock screw.

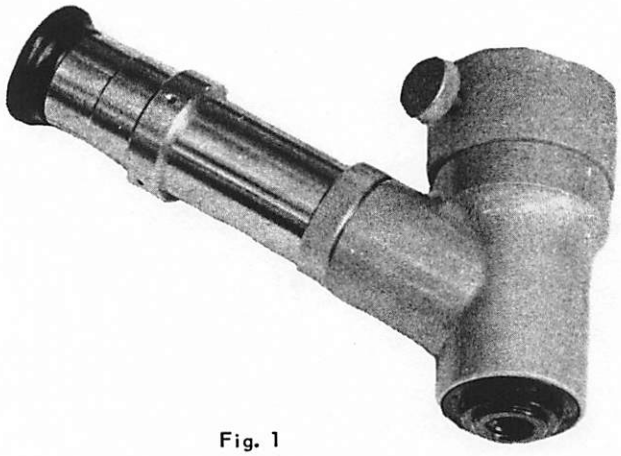


Fig. 1

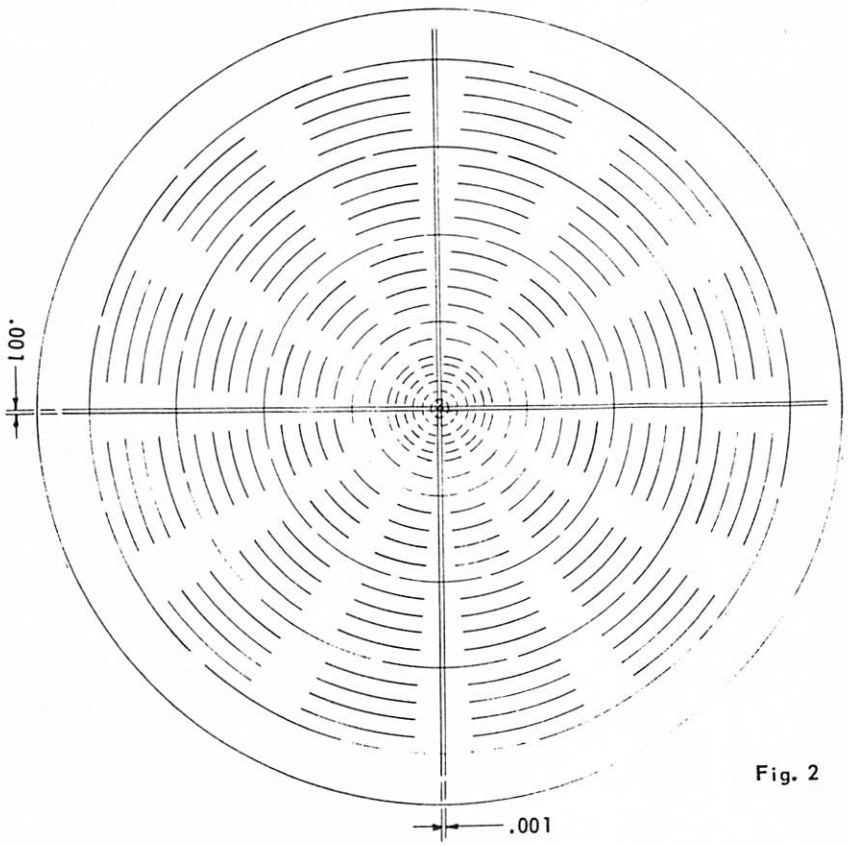


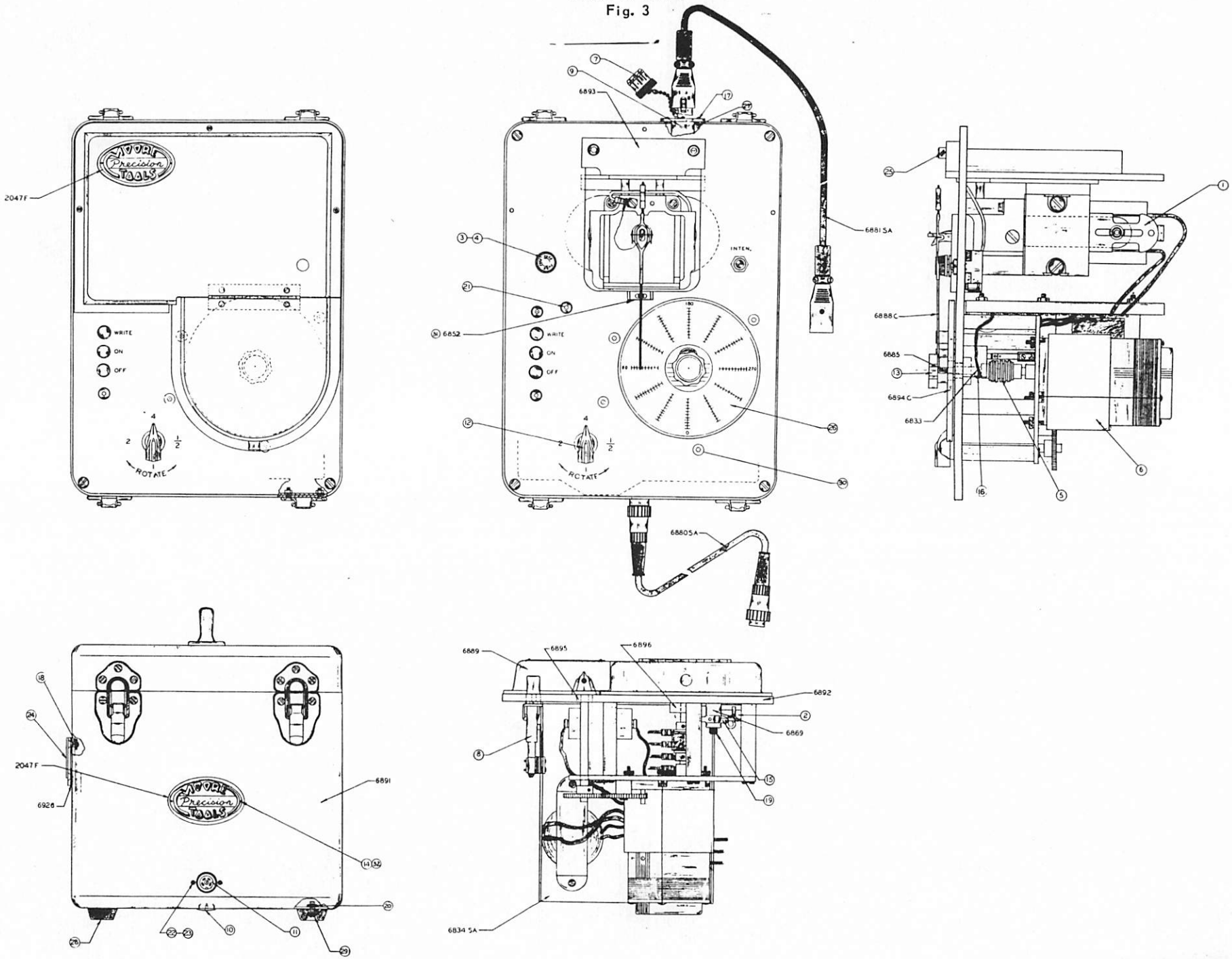
Fig. 2

Diam. of Circles (Inches)
.006
.012
.018
.024
.030
.036
.048
.060
.072
.084
.096
.108
.120
.132
.144
.156
.168
.180
.192
.204
.216
.228
.240

POLAR RECO ER ASSEMBLY

E-6890-A Rev. H

Fig. 3



USE OF POLAR RECORDER WITH FOUR SPEED GEAR RATIO MOTOR

This accessory for recording roundness or eccentricity is most conveniently located on mounting brackets on the right hand box of the Measuring Machine.

It will be noted that as shipped, the pen is packaged separately. To place the pen into position, remove the black plastic cover by removing the three (3) screws around the edge. Place the pen carefully into its pivots. Should pen balance need adjustment, this is accomplished by turning the small brass cylinders and thus moving them along the screw thread until the pen just bears lightly on the turn table.

An outlet is provided in the rear of the right hand control box. The 110V supply cable for the recorder is provided with matching plugs. One plug is inserted into the recorder box and the other is inserted into the outlet.

To zero out recorder to amplifier, turn on the amplifier switch to meter position. Zero the amplifier with the the probe tip against any convenient surface. Place a chart paper on the turn table. With the recorder control button in the ON position, turn meter switch to "meter and Record" on the Federal unit, or "External Output" on the Cleveland unit. The pen should be in the center range of divisions on the paper chart. If the pen is not in the position, there is a popout button on the bottom of the recorder box. Remove it and insert a screw driver into the adjustment slot in the bottom of the Esterline Angus element. Turn the screw in a CW or CCW direction to center the pen on the chart paper.

Calibration of the recorder to the amplifier is accomplished with the meter still set on zero. Move the machine table to obtain a meter reading of −.00005". Switch the meter to "Recorder" or "External Output", if the calibration is correct, the pen should move to the outermost graduation of the chart paper. Switch back to the recorder and re-position the table to read +.00005". Switch back to the recorder and the pen should move to the innermost graduation of the chart paper. Failure of the recorder to agree with the meter can be corrected by adjustment of the appropriately marked calibration screw on the machine meter control panel. (NOTE: When using the Federal amplifier, it is not necessary to switch back to meter as the panel has both a record and meter simultaneously.

The intensity of the pen is located on the top of the recorder. By rotating the screw you can control spark of the pen and thus the quality of line is produced.

USE OF STRIP RECORDER

This accessory for recording parallelism and straightness is most conveniently located on a small stand adjacent to the machine.

To zero and calibrate strip recorder, it is accomplished in the same manner as the polar recorder.

PRINCIPLES OF ELECTRONIC GAGE MEASUREMENT

Although it is not within the scope of this manual to discuss the broad subject of measurement, the essential principles related to the use of the electronic gage head for measurement will be explained. In order to do so it is first necessary to discuss the plane (imaginary surface) in which adjustments and measurements are made.

The vertical plane of measurement, Fig. 4, is defined as the plane established by the gage head, attached to the spindle by means of an adjustable linkage. This plane also passes through the axis of the spindle. It is in this plane that positioning movement of the gage head and measuring movement of the probe tip is made. Machine construction insures this relationship.

In order to achieve the highest accuracy of measurement it is necessary that the ball tip of the gage head probe be central with the spindle axis in a direction 90° to the vertical plane of measurement, Fig. 5. Since the probe is mounted in a ball and socket joint, this centrality is not insured except by adjustment which is performed as follows:

1. Position the gage head so as to bring the ball tip as close to central as possible by eye, rotating the spindle by hand during this operation and using the adjusting screw on the linkage for final setting in measuring direction. The ball tip is corrected for side displacement during this operation by pressing gently on the tip so as to pivot it from its ball and socket joint.

2. Greater accuracy of this sideways adjustment of the ball tip can be achieved by using any vertical surface, mounted on the table, as a reference, Fig. 6. Bring this surface within a few thousandths of the ball tip, at 90° to the vertical measuring plane.

3. Since the ball tip was centered only by eye, it must be assumed that it is slightly ahead or behind center of rotation, as well as off center sideways. Therefore, because the spindle must be turned 180° in order to check the sideways centrality of the ball, one should carefully determine in which direction the spindle should be rotated in order to keep the ball from bumping into the reference surface.

4. Having determined the proper direction, rotate the spindle back and forth through a 180° arc, Fig. 7, adjusting the tip sideways until the gap between the ball and the surface is equal in either position. This adjustment, once made, will remain accurate unless the tip is accidentally bumped in a sideways direction.

For indicating straightness, alignment or measuring the distance between surfaces which are parallel and with which the probe can contact in the same direction (that is without rotation of the spindle) Fig. 8, the location of the ball tip with relation to the spindle axis is not critical. However, it is desirable to have it reasonably close to center to facilitate setting the measuring movement of the gage head probe normal (at 90°) to the work surface to be contacted. This latter condition is achieved by rotating the spindle through a slight arc, with the ball tip in contact with the work, and setting the spindle at exactly the position at which the meter reading is either maximum or minimum, depending upon whether the bell tip is ahead or behind center in the measuring direction. All measurements must be made with the measuring movement of the probe thus square to the work surface!

Picking up the location or measuring the roundness of holes, male diameters and radii requires positioning of the gage head so that the probe tip swings on the same radius as that of the surface to be contacted. In practice this is usually best accomplished as follows:

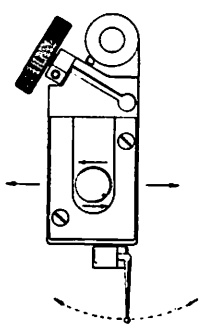


Fig. 4

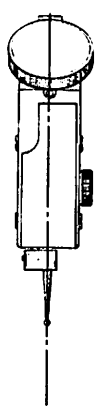


Fig. 5

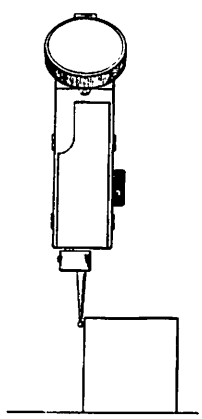


Fig. 6

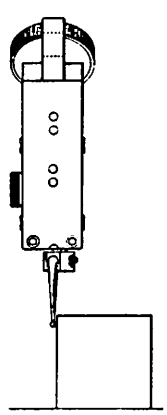


Fig. 7

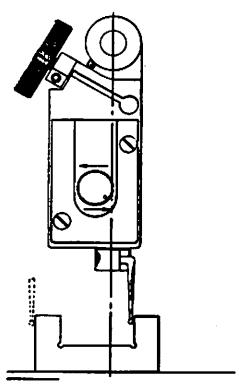


Fig. 8

1. Bring the center of the diameter to be located beneath the spindle axis as closely as possible by table movement.

2. With the ball tip just above the surface of the work, rotate the spindle and position the gage head so that it appears to be describing a circle of the required diameter. The table is now repositioned, if necessary, to bring the circle described by the ball tip concentric with the diameter of the workpiece.

3. Adjust the gage head so that the probe clears the work and lower the quill so that it is well below the top surface of the workpiece. Now gradually adjust the linkage adjusting screw, with the spindle being rotated and the meter set to read in "tenths", until the meter starts to register. Reposition the table, as required, to centralize the diameter in relation to the spindle axis. Bring the meter up to zero by the fine adjusting screw on the gage head and the centering knob on the panel. Now switch to the meter to the fine scale and complete the centralizing operation to the required degree of accuracy.

Some measurement, such as diameter of a hole, length between surfaces, Fig. 9, and location of coordinates along a contour require angular repositioning of the spindle in order to present the gage head normal to the work surface. In these and similar cases the first step is to establish the contact point of the ball exactly in line with the spindle axis. This operation is accomplished as follows:

1. Unless the workpiece itself provides a suitable surface, select a convenient location on the table to mount a suitable vertical reference surface. The requirements of this surface are that it be flat, straight and square to the machine table surface to a high degree of accuracy. These requirements are embodied in the Moore Pick Up Block, Fig. 10. The surface to be used is aligned with either travel of the machine by use of the gage head, and securely clamped in place. This surface should face the normal measuring movement of the other travel of the machine.

2. Wring a gage block, or piece with an equivalent surface, to the reference surface so that it projects at least 1/4" above the edge. If wringing is not possible this piece can be held or very lightly clamped against the reference surface.

3. Use the leadscrew to bring the ball tip in contact with the reference surface at a point approximately 1/8" below the edge and just beside the wrung on piece, Fig. 11. Turn the spindle through a slight arc to establish a position normal to the surface and bring the meter up to zero. Note the leadscrew dial and scale reading at this point. Raise the quill so that the ball is just clear of the top edge of the reference surface. Rotate the spindle 180°.

4. Use table movement to bring the ball tip into contact with the wrung on piece, Fig. 12. This requires use of the leadscrew in an opposite rotation to that used for positioning. Establish the normal positioning as above. Move the table so as to bring the meter to the maximum plus reading of its scale. Now, using the leadscrew in its normal direction of rotation, move that table so as to back the meter down to zero. Note the leadscrew dial and scale reading at this point.

5. By adding one dial reading to the other a value will be obtained which divided by 2 will give the setting to be made on that dial in order to set the reference surface almost exactly beneath the spindle axis. This setting should now be made.

6. Using extreme care not to bump the ball tip vertically, and adjusting gage head position as necessary bring the tip into contact with the reference surface as in step 3. By further adjustment of the head and centering knob on panel bring the meter to zero. Raise the quill again as in step 3 and rotate the spindle 180°.

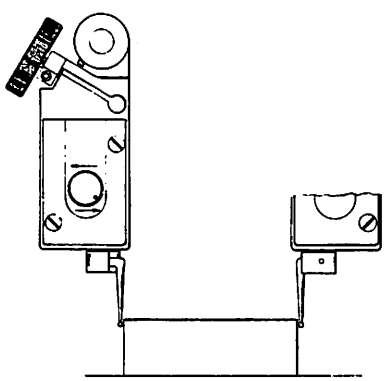


Fig. 9

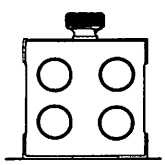


Fig. 10

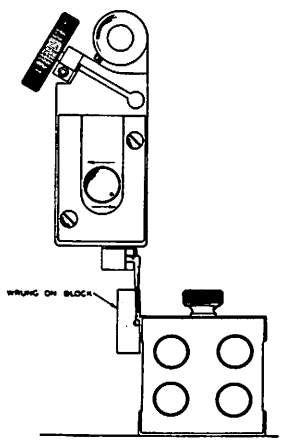


Fig. 11

7. Using only the leadscrew controlling table travel parallel to the reference surface, bring the ball into contact with the surface of the wrung on piece. Establish the normal position and note the meter reading. Half the difference between this reading and the zero set on the opposite side is the amount now necessary to finally move the table to put the surface exactly under the spindle axis. This may easily be done by using the meter as a guide. The final proof being the ability to alternately position the ball tip against either the reference surface or the wrung surface with identical meter readings. The surface is now directly in line with the spindle axis and the meter should be set to zero by the centering knob or the fine adjustment screw on the gage head if necessary. Once this setting is made the condition is established where a point on the face of the ball is exactly on the spindle axis with the meter reading zero, Fig. 13. In any measurement made based on this principle do not again adjust the gage head or the centering knob on the panel.

Having established this relation of ball tip to axis a variety of absolute measurements may be made. As an example, measurement of the diameter of a hole will now be explained.

In measuring the diameter of a hole with a point on the ball face exactly in line with the spindle axis, with a zero meter reading, it is not necessary to pick up the center of the hole but it is necessary to determine a center line or diameter which can then be measured.

Introduce the gage tip into the hole and bring it into normal contact with the surface at a point such as Fig. 14. A. Bring the meter to zero and record the leadscrew position work so as to cause probe contact at a point opposite. B. – Zero the meter and record the leadscrew dial reading. Half way between these settings is the true center line of the hole. Set dial to this position and measure the diameter by zeroing the meter with ball tip at points C and D. Obviously it is necessary to rotate the spindle 180° after reading at C and before approaching contact at D. Also, it is necessary to back the meter down at point D as has previously been described. The difference between leadscrew dial readings at C and D represents hole diameter.

From the example it should be clear that by the same means length between opposing terminal faces, coordinate points along contoured surfaces and a wide variety of other measurements can readily be made.

SUMMARY

Most of the uncertainties of precise measurement can be traced in one way or another to temperature. This is illustrated by pointing out the fact that as little as 1/4° F temperature difference produces a dimensional change of over twenty millionths of an inch in a distance of 15". Very few temperature indicating instruments are sensitive enough to show such a small variation.

This illustration shows how important it is to insure uniform temperature conditions between the workpiece and the machine by allowing adequate time for equalization of temperature before attempting to make any final measurements of high accuracy.

Observation of the general rules of measurement set forth on the left hand panel of the machine will greatly increase the certainty of measurement made on this machine.

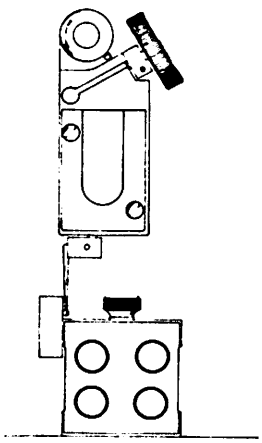


Fig. 12.

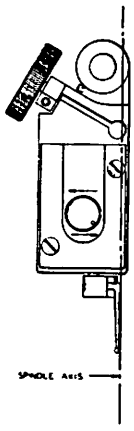


Fig. 13

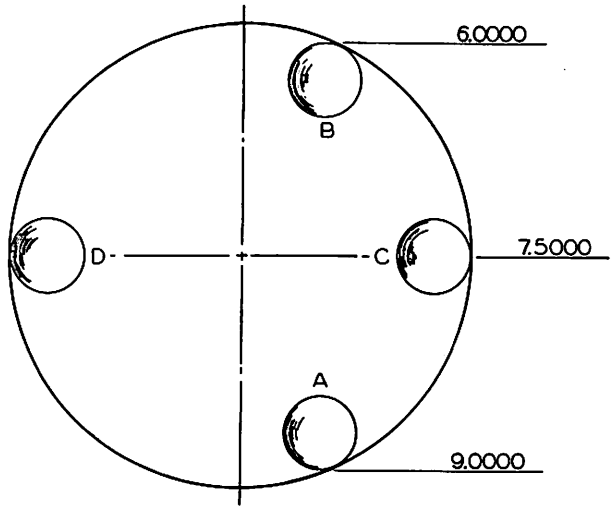


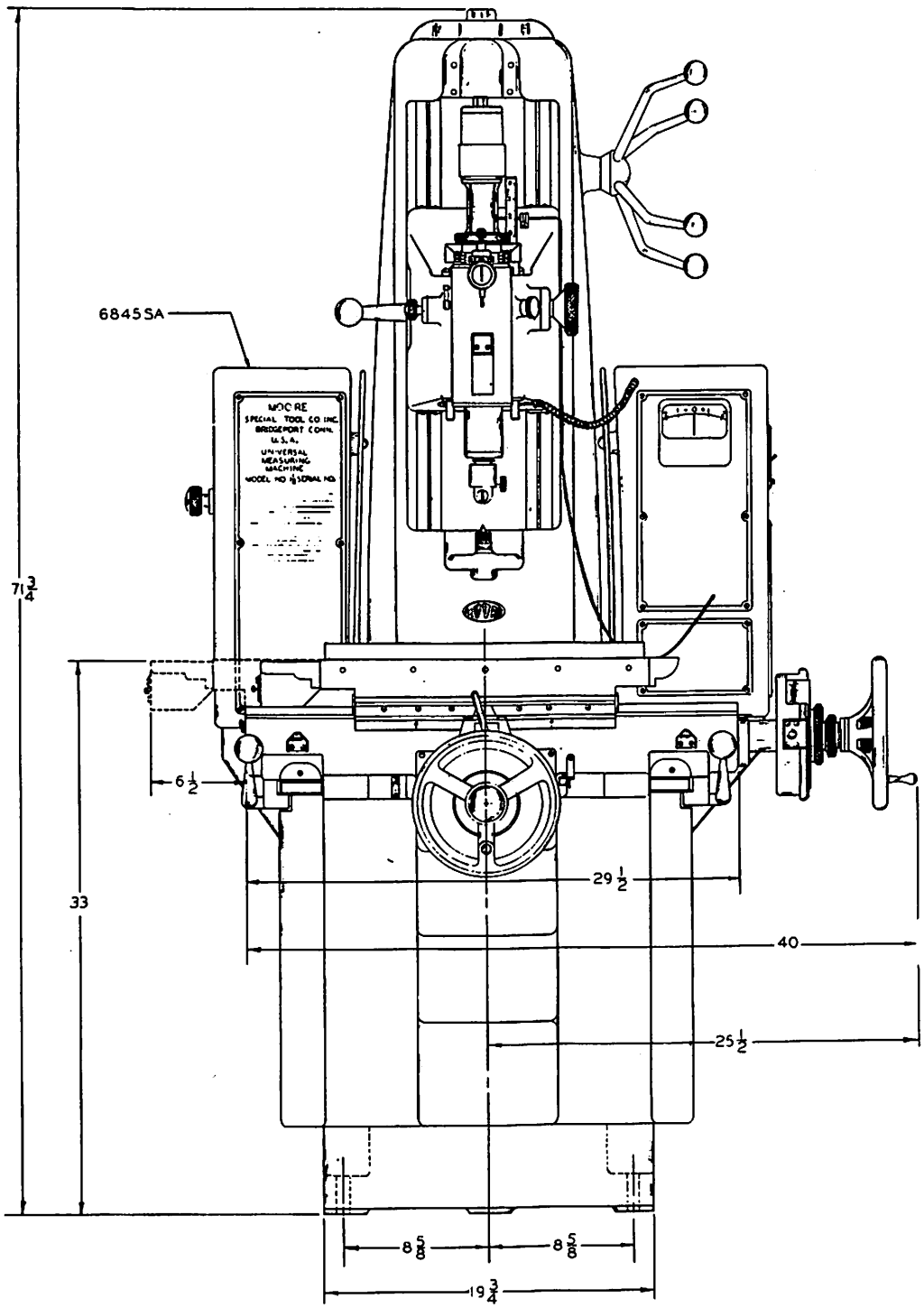
Fig. 14

PARTS LIST—DRAWINGS

MODEL 1½

MEASURING MACHINE MAJOR ASSEMBLY

Fig. 15



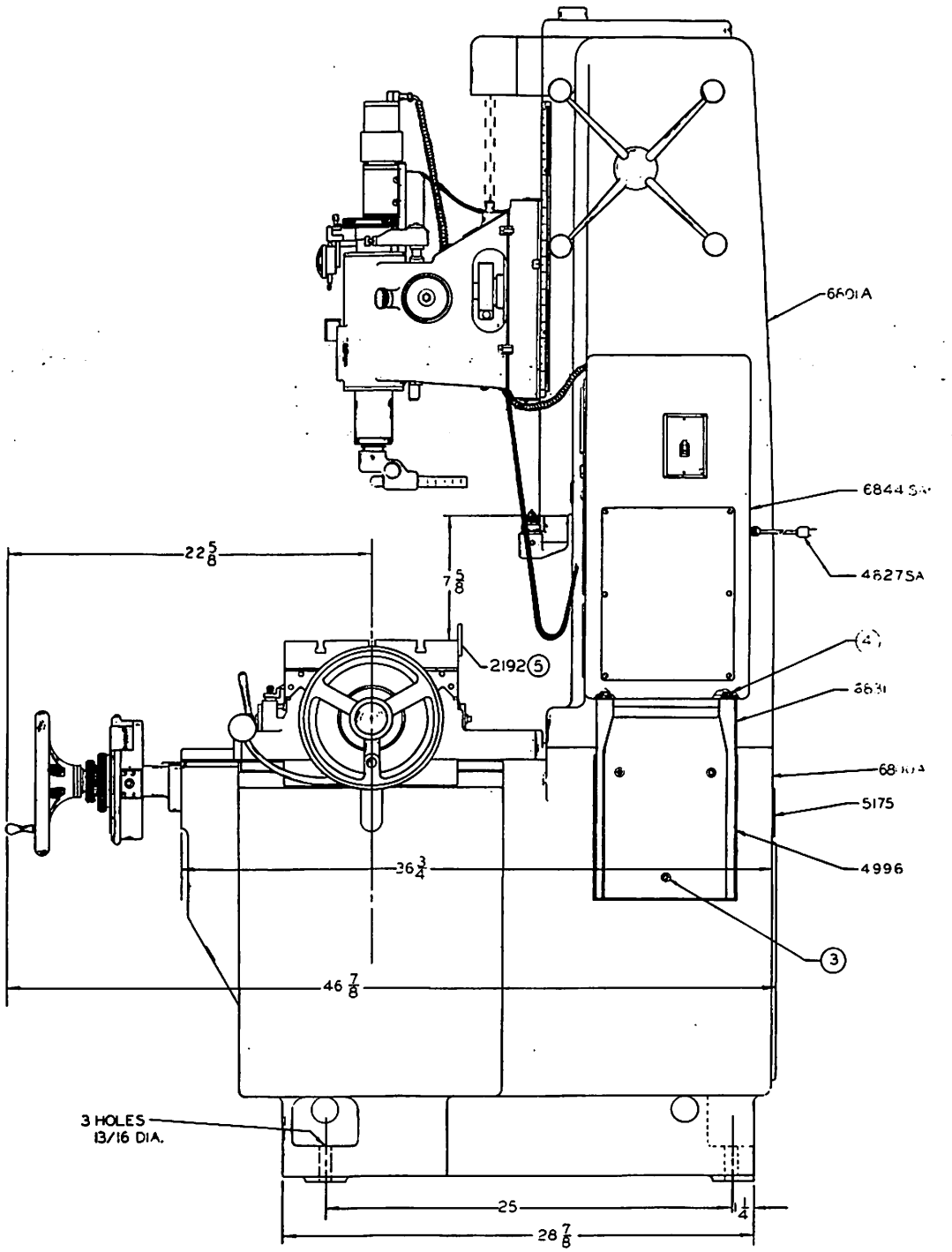
PART NO.	NAME
* 114A	Tee Wrench size 7/32 hex.x 6" Lg.
	Tee Wrench size 3/16 hex.x 6" Lg.
	Tee Wrench size 5/32 hex.x 5" Lg.
	Tee Wrench size 1/8 hex.x 5" Lg.
2192	Straight-edge
*2409	1" – 2" & 4" Micro Stop Blocks
*2436	Spring Clip
*3050A	Moore Indicator Holder Assembly
*4827SA	Electrical Installation
*4856C	Extention Link-Indicator Holder
*4965SA	Moore Precision Pick Up Block Assem.
4996	Rubber Gasket
5175	Warning Plate (Installation)
6800A	Base Assembly
6801A	Column Assembly
6831	Control Box Support
6844SA	R. H. Box Subassembly
6845SA	L. H. Subassembly
*6876	3/8" Spindle Adapter
*6877	1/2 Spindle Adapter
†4854A	Collimated Light Assembly
†4855A	Transparent Stage Assembly
†4920A	Microscope Assembly
†6890A	Polar Recorder Assembly with Hangers
†	Variable Transformer, Jefferson Electric 069-001-643 for Collimated Light Assem.

MODEL 1½

OUTLINE & FOUNDATION LAYOUT

E-6899-A Rev. F

Fig. 16



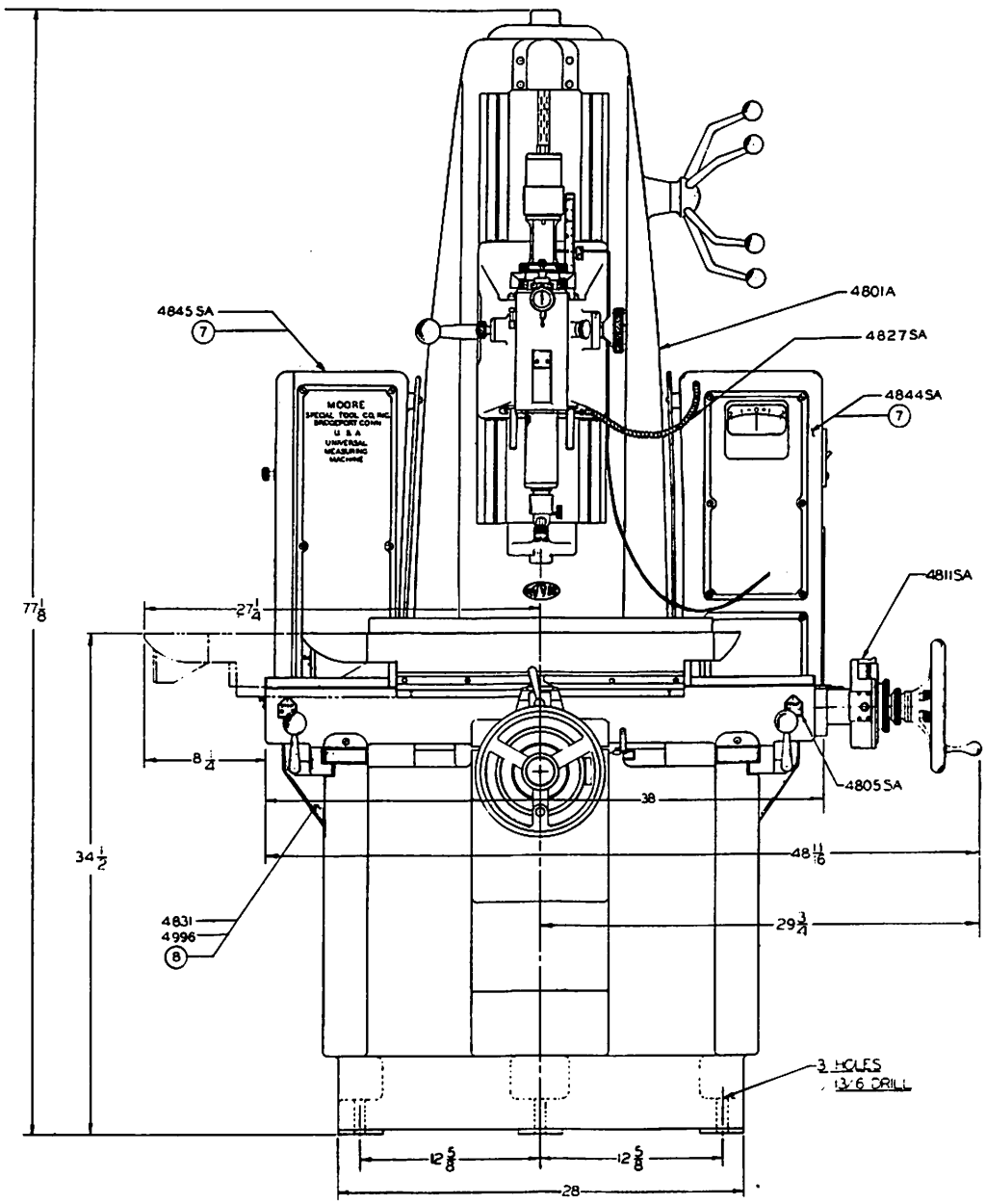
ITEM NO.	NAME		
*1	Can of Sunoco Way Lubricant (SAE 80)	4	1/4 – 20 x 5/8 Hex. Sock. Cap Scr.
*2	Velocite #6051 (Quill Bushing Lub.)	5	5/16 – 18 x 5/8 Hex. Sock. Cap Scr.
3	5/16 – 18 x 1" Hex. Sock. Cap Scr.	*6	Unbrako Hex. Key Fold #2 (metric mach. only

*STANDARD ACCESSORIES
† OPTIONAL ACCESSORIES

MODEL 3

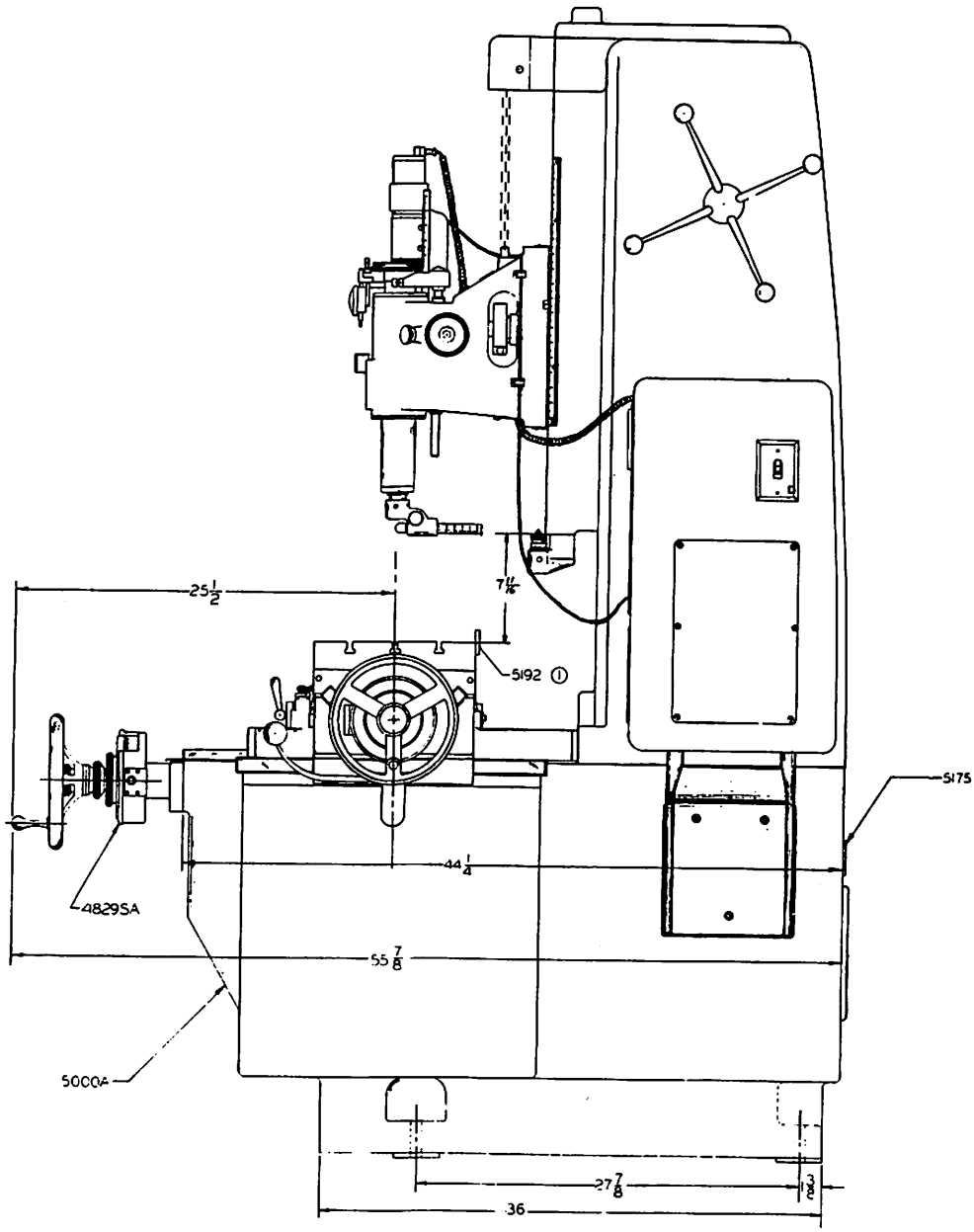
MEASURING MACHINE MAJOR ASSEMBLY

Fig. 17



PART NO.	NAME
* 114A	Tee Wrench size 1/8 hex. x 5" Lg.
* 114A	Tee Wrench size 5/32 hex. x 5" Lg.
* 114A	Tee Wrench size 3/16 hex. x 6" Lg.
* 114A	Tee Wrench size 7/32 hex. x 6" Lg.
* 2409	1" – 2" – 4" Micro Stop Blocks
* 2436	Spring Clip
* 3050A	Moore Indicator Holder Assembly
4801A	Column Assembly
4805SA	Limit Stop Installation
4811SA	Cross Slide Lead Screw Sub-Assem.
4827SA	Electrical Installation
4829SA	Table Lead Screw Sub-Assem.
4831	Control Box Support
4844SA	R. H. Control Box Subassem.
4845SA	L. H. Control Box Subassem.
* 4854A	Collimated Light Assembly
* 4855A	Transparent Stage Assembly
* 4920A	Microscope Assembly
* 4965SA	Moore Pickup Block Sub-Assem.
4996	Rubber Gasket
5000A	Table & Cross Slide Assem.
5175	Warning Plate
5192	Straight-Edge
* 6876	3/8" Spindle Adapter
* 6877	1/2" Spindle Adapter
† 6890A	Polar Recorder

MODEL 3
OUTLINE & FOUNDATION LAYOUT
E-4999-A Rev. J
Fig. 18



ITEM NO.	NAME
1	5/16 – 18 x 5/8 Sock. Hd. Cap Scr.
*2	Electronic Indicator Gage Head with 1/8" Tip & 2 extra Gage Head Tips with Clamps & Keys (1/16" & 1/32")
*3	Variable Transformer, Jefferson Electric – 069-001-643, for Collimated Light
*5	Can of Sunoco Way Lubricant (SAE 80)
*6	Velocite #6051 (Quill Bushing Lubricant)
7	1/4 – 20 x 5/8 Sock. Hd. Cap Scr.
8	5/16 – 18 x 1" Sock. Hd. Cap Scr.
*9	Unbrako Hex. Key Fold #2 (Metric Mach. Only)

* STANDARD ACCESSORIES
† OPTIONAL ACCESSORIES

PART NO.	NAME
2042	Moore Name Plate
2090SA	Spider Sub-Assembly
2293	Observation Brackets
2294	Column Zero Bracket
2746	Sprocket
4824	Wiring Diagram Electrical Controls
4834SA	Sprocket Housing Assembly
4842SA	Pulley Sub-Assembly
5215SA	Micrometer Stop Assembly
5695	Column Observation Scale
6315	Bolt Bushing
6801C	Column
6806	Column Cap
6809	Guide Bar
6837A	Counterweight Assembly
6843	Spider Wheel Shaft
6870A	Spindle Housing Assembly

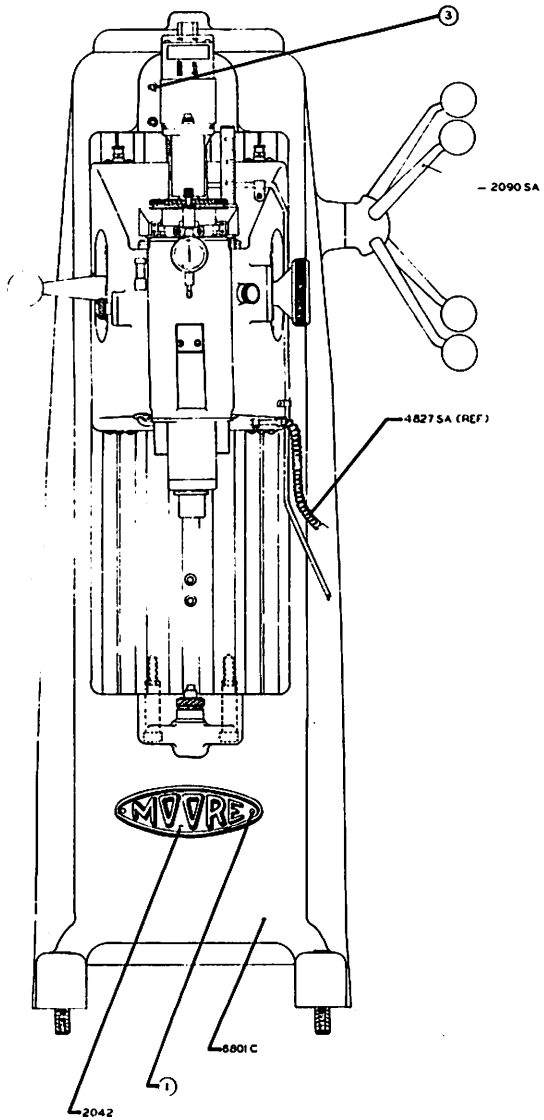
ITEM NO.	NAME
1	#0-1/4 Type "U" Drive Scr. (Parker Kalon)
3	5/16 – 18 x 2 Lg. Hex. Sock. Hd. Cap Scr.
4	1" – 8 Thd Eye Bolt 2 Dia. Eye 9 Shank 2 Thd.
5	3/8 – 16 x 1-1/4 Lg. Hex. Sock. Cap Screw
6	5108-75 Waldes Retaining Ring
7	#6 – 32 x 1/4 Lg. Round Hd. Mach. Screw
8	#6 – 32 x 1/4 Lg. Fillister Hd. Mach. Scr.
9	1/16 Bethlehem 6 x 7 Galvanized Aircraft Strand & Cord
10	#40 American Standard Roller Chain
11	3/8 – 16 x 3/4 Lg. Hex. Sock. Hd. Cap Screw
12	5/8 x 2-1/4 Lg. Shoulder Screw
13	5/32 x 1-1/2 Lg. Cotter Pin
14	5/8 – 11 x 3 Lg. Hex. Sock. Hd. Cap Scr.
15	5/8 – 11 x 4-1/4 Lg. Hex. Sock. Hd. Cap Scr.
16	No. 61 Woodruff Key
17	1/4 – 20 x 1/2 Lg. Hex. Sock. Set Screw
19	Waldes Snap Rings 5108-87
21	10 – 32 x 1/4 Lg. Hex. Sock. Set Screw

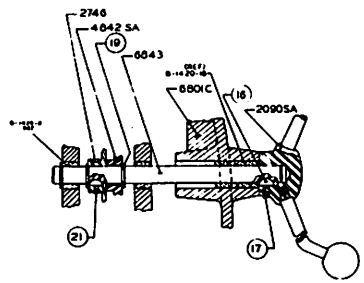
MODEL 1½

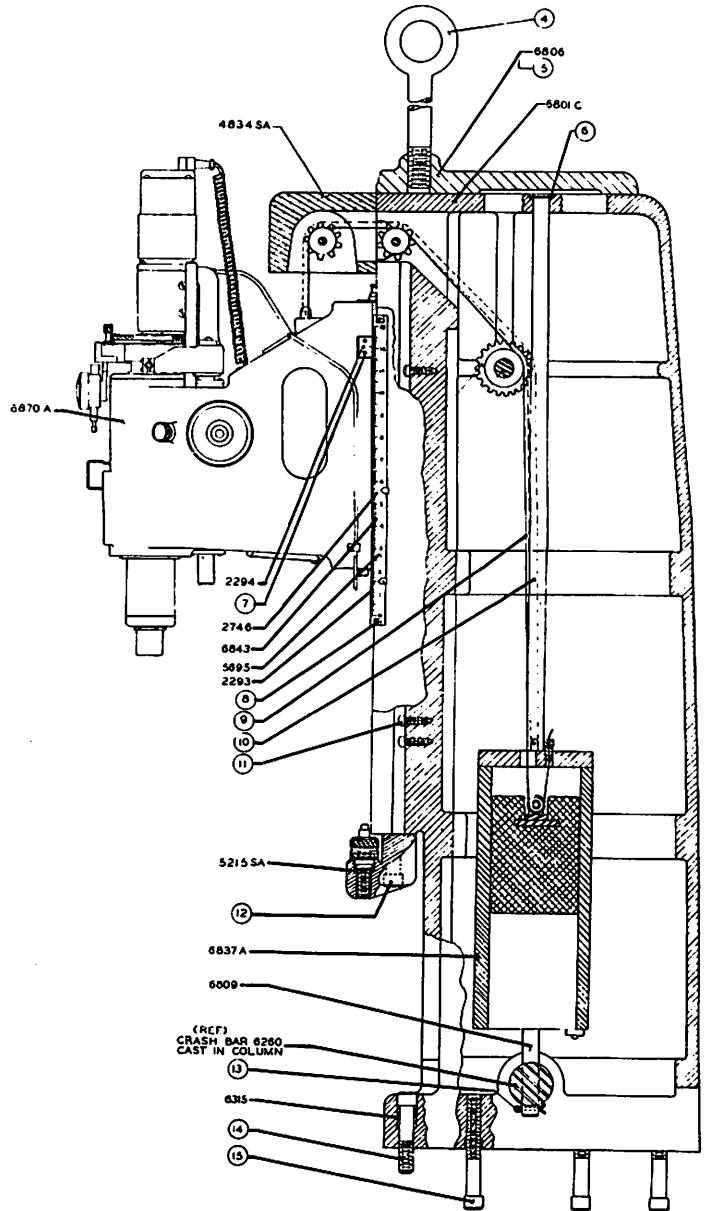
COLUMN ASSEMBLY

E-6801-A Rev. G

Fig. 19



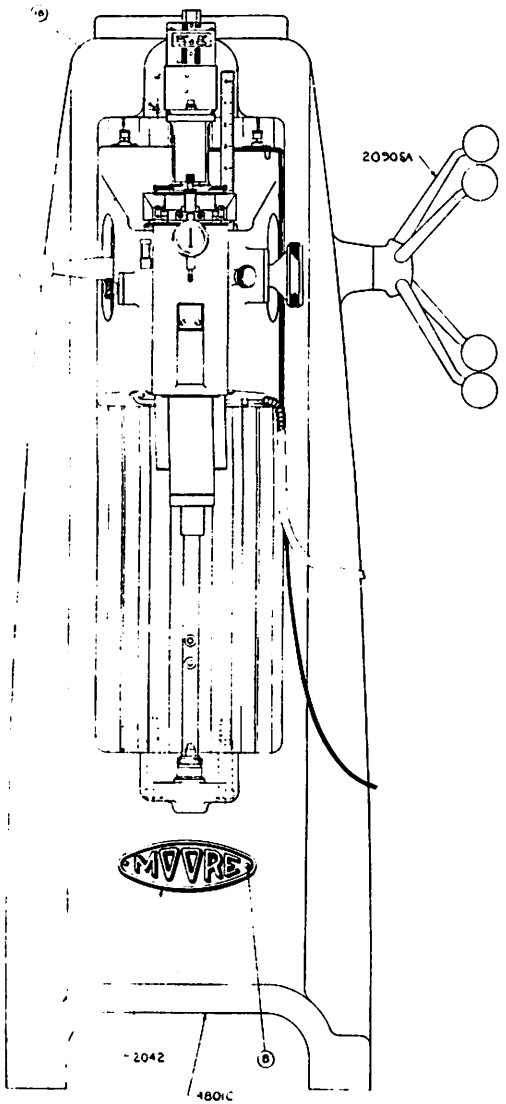


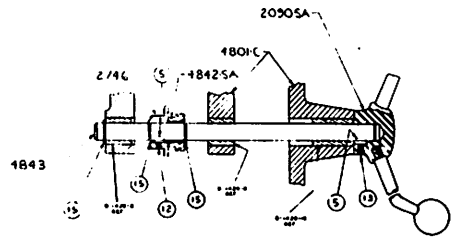


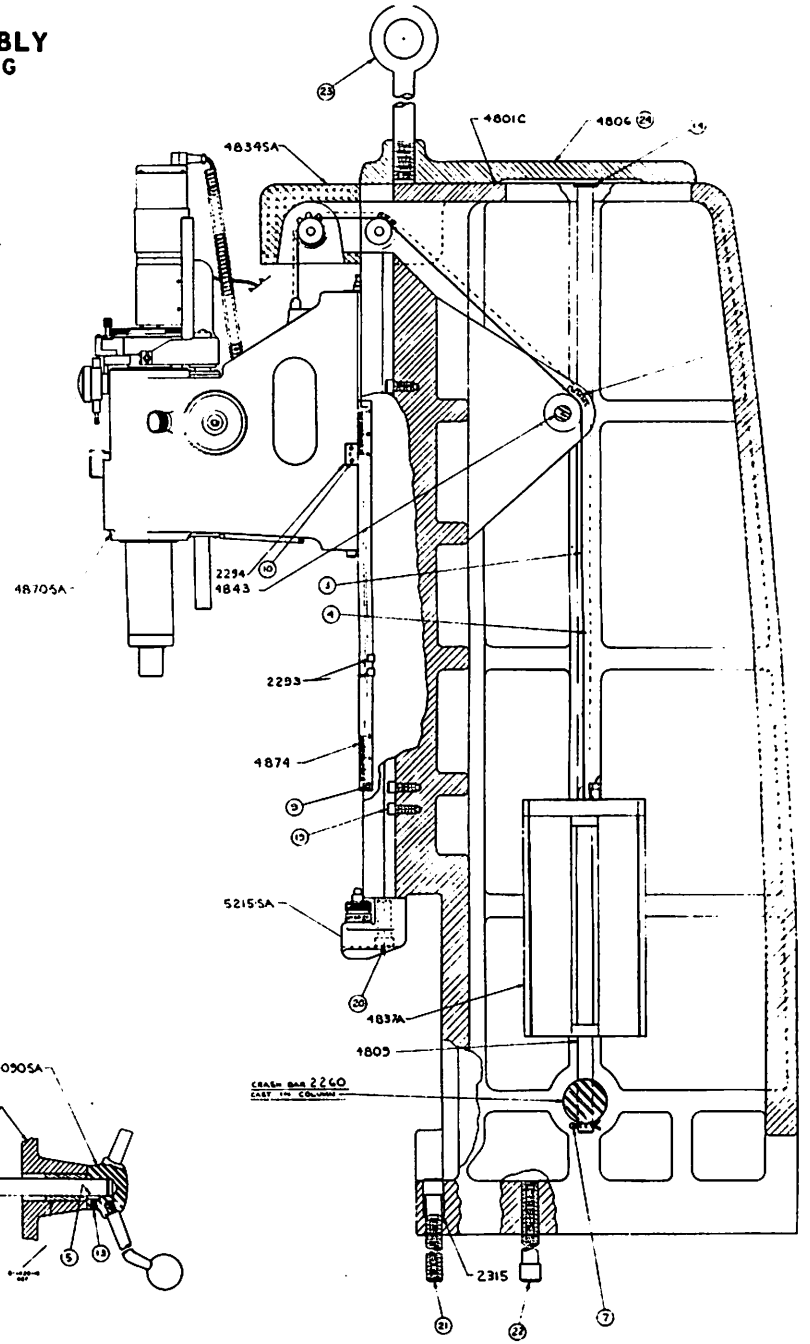
PART NO.	NAME
2042	Moore Name Plate
2090SA	Spider Sub-Assembly
2294	Column Zero Bracket
2293	Observation Brackets
2315	Bolt Bushing
2746	Sprocket
4801C	Column
4806	Column Cap
4809	Guide Bar
4824	Wiring Diagram, Electrical Con.
4827SA	Electrical Installation – Ref.
4834SA	Sprocket Housing Assembly
4837A	Counterweight Assembly
4842SA	Pulley Sub-Assembly
4843	Spider Wheel Shaft
4870SA	Spindle Housing Sub-Assembly
4874	Column Observation Scale
5215SA	Micrometer Stop Assembly

ITEM NO.	NAME
3	1/16 Bethlehem 6 x 7 Galvanized Aircraft Strand & Cord
4	#40 American Stand. Roller Chain
5	61 Woodruff Key
7	5/32 x 1-1/2 Lg. Cotter Pin
8	0 – 1/4 Type "U" Drive Scr. (Parker Kalon)
9	#6 – 32 x 1/4 Fillister Hd. Cap. Scr.
10	#6 – 32 x 1/4 Round Hd. Mach. Scr.
12	#10 – 32 x 1/4 Soc. Hd. Set Scr.
13	1/4 – 20 x 1/2 Soc. Hd. Set Scr.
14	5108-75 Waldes Retaining Ring
15	5108-87 Waldes Retaining Ring
18	5/16 – 18 x 2 Soc. Hd. Cap. Scr.
19	3/8 – 16 x 3/4 Soc. Hd. Cap. Scr.
20	5/8 x 2-1/4 Shoulder Scr.
21	3/4 – 10 x 3-1/2 Soc. Hd. Cap. Scr.
22	3/4 – 10 x 5 Soc. Hd. Cap. Scr.
23	1 – 8 Thd. Eye Bolt 2" Dia. Eye, 9" Lg., 2" Thd.
24	3/8 – 16 x 1-1/4 Soc. Hd. Cap. Scr.

MODEL 3
COLUMN ASSEMBLY
E-4801-A Rev. G
Fig. 20







PART NO.	NAME
98	Spring Disc
119	Squ. Wire Spring
178	Control Ball
2112	Q.H. Tee Bolt
2216	Stop Button
2217	Screw-Spindle
2617	Chain Terminal
2640	Clamp Handle
4803	Q.H. Clamp
4859	Yoke Washer
4870	Spindle Housing
4873	Clamp Pad
4875	Felt Holder
4876	Quill Felt
4880	Shoulder Scr. Stop Plug
4881	C'sink Washer
4889	Q.H. Bushing
4892	Pulley Stud
4893SA	Pulley Sub-Assembly
4895	Knob
4896	Pinion Shaft
4898	Pinion Pulley
4899	Bearing Cap
4900C	Yoke
4903	Knob
4906	Block Base
4907	Indicator Plate
4909	Nameplate – Spindle Oil Fitting
4910	Bearing Sleeve
4915	Clamp Pad Washer
4925	Indicator Block
4968	Yoke Cover
4990SA	Indicator Mount Assy.
4999	Indicator Plate
5049	Male Chip Wiper (Bottom)
5064	Q.H. Vee Way
5073	Q.H. Chip Wiper Felt (Bottom)
5890	Oil Cup Adapter
5891	Male Chip Wiper (Top)
5892	Q.H. Chip Wiper Felt (Top)
6807	Rubber Bumper
6810	Left Hand Upper Bushing Washer
6814	Take-up Washer
6815	Right Hand Upper Bushing
6816	Left Hand Upper Bushing
6818	Bottom Bushing
6820	Right Hand Upper Bushing Washer
6825	Quill Pin Support
6826	Quill Pins
6874	Brush Spacer
6882SA	Main Spindle Sub-Assy.
6897	Guide Rod
6899	Pinion Lock Screw
6901	Vert. Scale
6909A	Friction Clutch Assembly
6920A	Spindle Lock Assembly
6922	Washer
6923	Mounting Ring
6924	Spacer
6925	Yoke Bushing
6957A	Oiler Assembly
6997	Travel Limit Stud
6884	quill

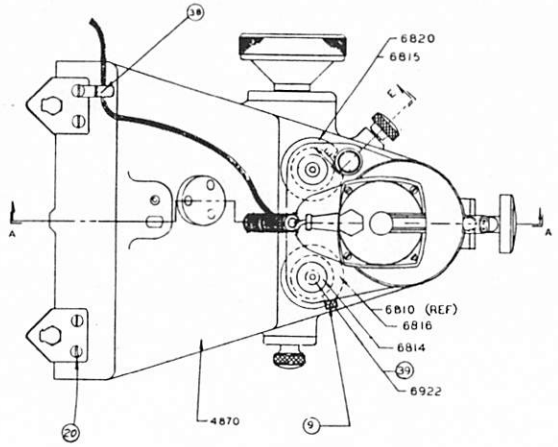
ITEM NO.	NAME
1	Slip Ring & Brush Block Assembly – Northern Precision #200609
2	1/4 – 20 x 1-1/2 Sock. Cap Scr.
3	6 – 32 x 3/8 Sock. Cap Scr.
4	1/4 – 20 x 3/8 Shoulder Scr.
5	1/4 – 20 x 1/2 Squ. Hd. Scr.
6	3/8 – 16 x 1 Sock. Cap Scr.
7	6 – 32 x 1/2 Fl. Hd. Sock. Scr.
8	Apcor Mod. 2202010
9	6 – 32 x 1/4 Round Hd. Mach. Scr.
12	5 – 40 x 3/8 Fl. Hd. Sock. Scr.
13	1/4 – 20 x 3/8 Fl. Hd. Sock. Scr.
14	1/4 – 20 x 1 Fl. Hd. Sock. Scr.
15	
16	6 – 32 x 3/4 Sock. Cap Scr.
17	Bost – Bronz B-69-4
18	10 – 32 x 3/8 Sock. Set Scr.
19	8 – 32 x 3/8 Sock. Cap Scr.
20	10 – 32 x 3/8 Round Head Scr.
21	Bost – Bronz B-812-6
22	Gits Oiler B-107
23	Tube Clip #3121-1-3 Nielsen Hydraulic
24	#0 x 1/4 Type "U" Drive Scr. (Parker-Kalon)
25	Ames Ind. Adj. Bracket Type 111
26	Heyco #5PI
28	"O" Ring #6
29	#10 – 32 x 3/8 Button Hd. Sock. Scr.
30	#4 – 40 x 1/2 Sock. Hd. Cap Scr.
31	Cleveland #329 Mod. #T-300
31A	Federal
32	#10 – 32 x 3/4 Sock. Hd. Cap Scr.
33	#5 – 40 x 7/8 Button Hd. Sock. Cap Scr.
34	Koiled Kord #4-7038-01-01 PVC
35	
36	Strain Relief 1/16 Dia.
37	
38	Alsco Finger Spring B-1 1-1/2 x .015
39	#10 – 32 x 3/4 Button Hd. Sock. Cap Scr.
40	#4 – 40 x 5/8 Button Hd. Sock. Cap Scr.

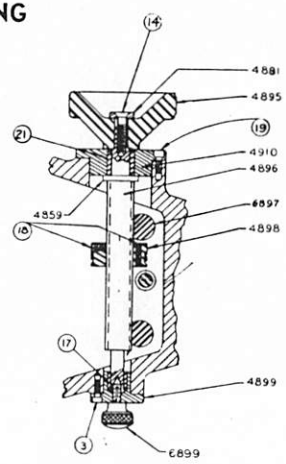
MODEL 1½

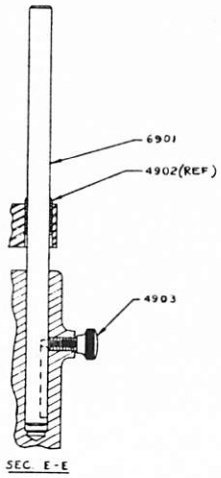
SPINDLE HOUSING

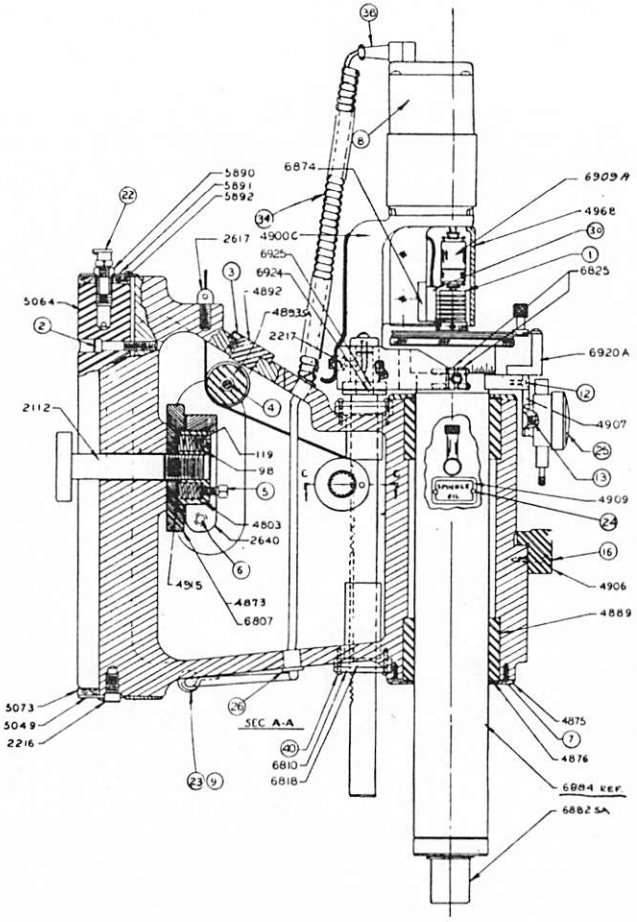
D-6870-A Rev. Q

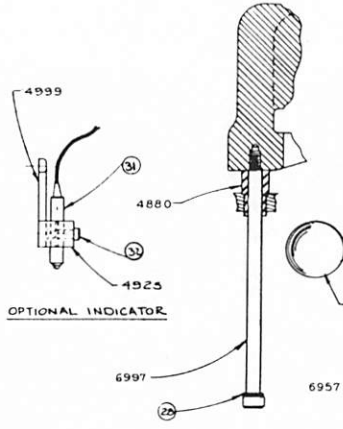
Fig. 21

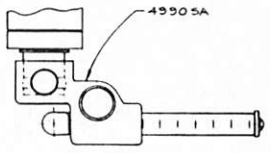


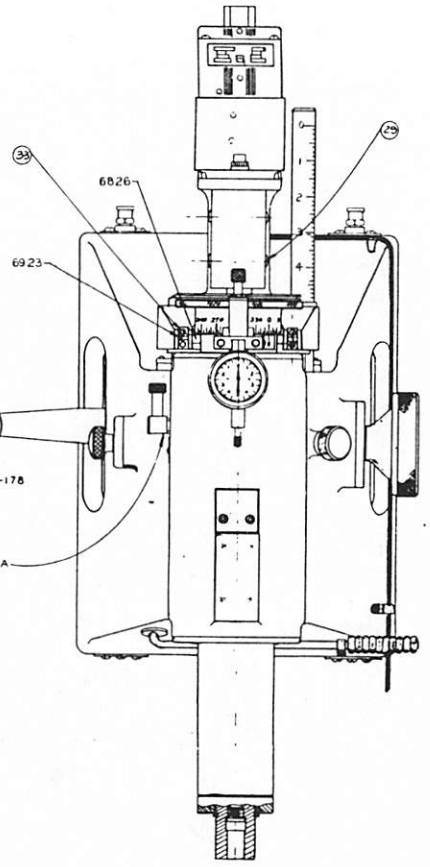












PART NO.	NAME
98	Spring Disc
119	Squ. Wire Spring
178	Control Ball
2112	Q.H. Tee Bolt
2216	Stop Button
2217	Screw - Spindle
2617	Chain Terminal
2640	Clamp Handle
4803	Q.H. Clamp
4859	Yoke Washer
4870	Spindle Housing
4873	Clamp Pad
4875	Felt Holder
4876	Quill Felt
4880	Shoulder Scr. Stop Plug
4881	C'sink Washer
4882SA	Main Spindle Sub-Assy.
4889	Q.H. Bushing
4892	Pulley Stud
4893SA	Pulley Sub-Assembly
4895	Knob
4896	Pinion Shaft
4897	Guide Rod
4898	Pinion Pulley
4899	Bearing Cap
4900C	Yoke
4901	Vert. Scale
4903	Knob
4906	Block Base
4907	Indicator Plate
4909	Nameplate – Spindle Oil Fitting
4910	Bearing Sleeve
4915	Clamp Pad Washer
4925	Indicator Block
4968	Yoke Cover
4990SA	Indicator Mount Assy.
4997	Travel Limit Stud
4999	Indicator Plate
5049	Male Chip Wiper (Bottom)
5064	Q.H. Vee Way
5073	Q.H. Chip Wiper Felt (Bottom)
5890	Oil Cup Adapter
5891	Male Chip Wiper (Top)
5892	Q.H. Chip Wiper Felt (Top)
6807	Rubber Bumper
6810	Left Hand Upper Bushing Washer
6814	Take-Up Washer
6815	Right Hand Upper Bushing
6816	Left Hand Upper Bushing
6818	Bottom Bushing
6820	Right Hand Upper Bushing Washer
6825	Quill Pin Support
6826	Quill Pins
6874	Brush Spacer
6899	Pinion Lock Screw
6909A	Friction Clutch Assembly
6920A	Spindle Lock Assembly
6922	Washer
6923	Mounting Ring
6924	Spacer
6925	Yoke Bushing
6957A	Oiler Assembly
4884	QUILL

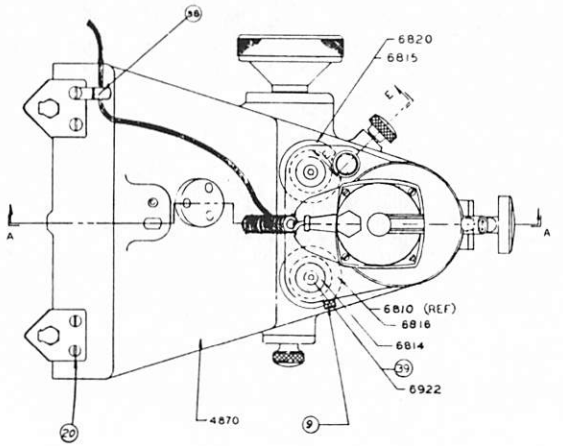
ITEM NO.	NAME
1	Slip Ring & Brush Block Assembly – Northern Precision #200609
2	1/4 – 20 x 1-1/2 Sock. Cap Scr.
3	6 – 32 x 3/8 Sock. Cap Scr.
4	1/4 – 20 x 3/8 Shoulder Scr.
5	1/4 – 20 x 1/2 Squ. Hd. Scr.
6	3/8 – 16 x 1 Sock. Cap Scr.
7	6 – 32 x 1/2 Fl. Hd. Sock. Scr.
8	Apcor Mod. 2202010
9	6 – 32 x 1/4 Round Hd. Mach. Scr.
12	5 – 40 x 3/8 Fl. Hd. Sock. Scr.
13	1/4 – 20 x 3/8 Fl. Hd. Sock. Scr.
14	1/4 – 20 x 1" Fl. Hd. Sock. Scr.
15	
16	6 – 32 x 3/4 Sock. Cap Scr.
17	Bost – Bronz B-69-4
18	10 – 32 x 3/8 Sock. Set Scr.
19	8 – 32 x 3/8 Sock. Cap Scr.
20	10 – 32 x 3/8 Round Head Scr.
21	Bost – Bronz B-812-6
22	Gits Oiler B-107
23	Tube Clip #3121-1-3 Nielsen Hydraulic
24	#0 x 1/4 Type "U" Drive Scr. (Parker-Kalon)
25	Ames Ind. Adj. Bracket Type 111
26	Heyco #5PI
28	"O" Ring #6
29	#10 – 32 x 3/8 Button Hd. Sock. Scr.
30	#4 – 40 x 1/2 Sock. Hd. Cap Scr.
31	Cleveland #329 Mod. #T-300
31A	Federal
32	#10 – 32 x 3/4 Sock. Hd. Cap Scr.
33	#5 – 40 x 7/8 Button Hd. Sock. Cap Scr.
34	Koiled Kord #4-7038-01-01 PVC
36	Strain Relief 1/16 Dia.
38	Alsco Finger Spring B-1 1-1/2 x .015
39	#10 – 32 x 3/4 Button Hd. Sock. Cap Scr.
40	#4 – 40 x 5/8 Button Hd. Sock. Cap Scr.

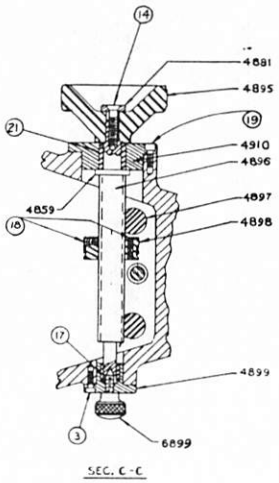
MODEL 3

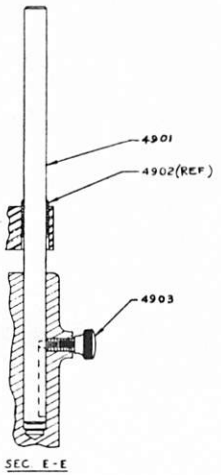
SPINDLE HOUSING

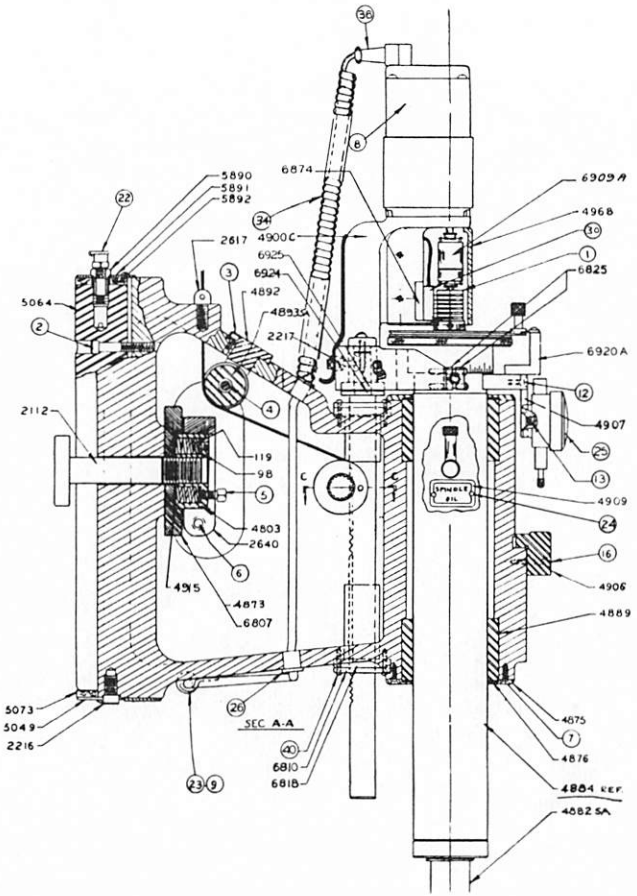
D-4870-A Rev. Q

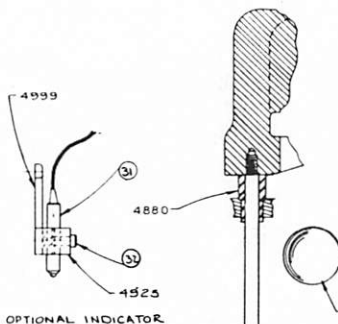
Fig. 22

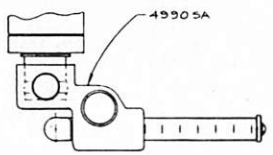


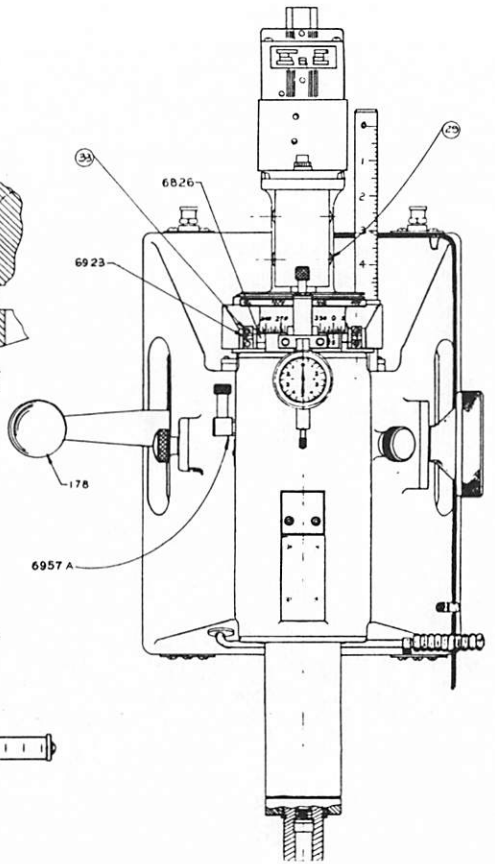








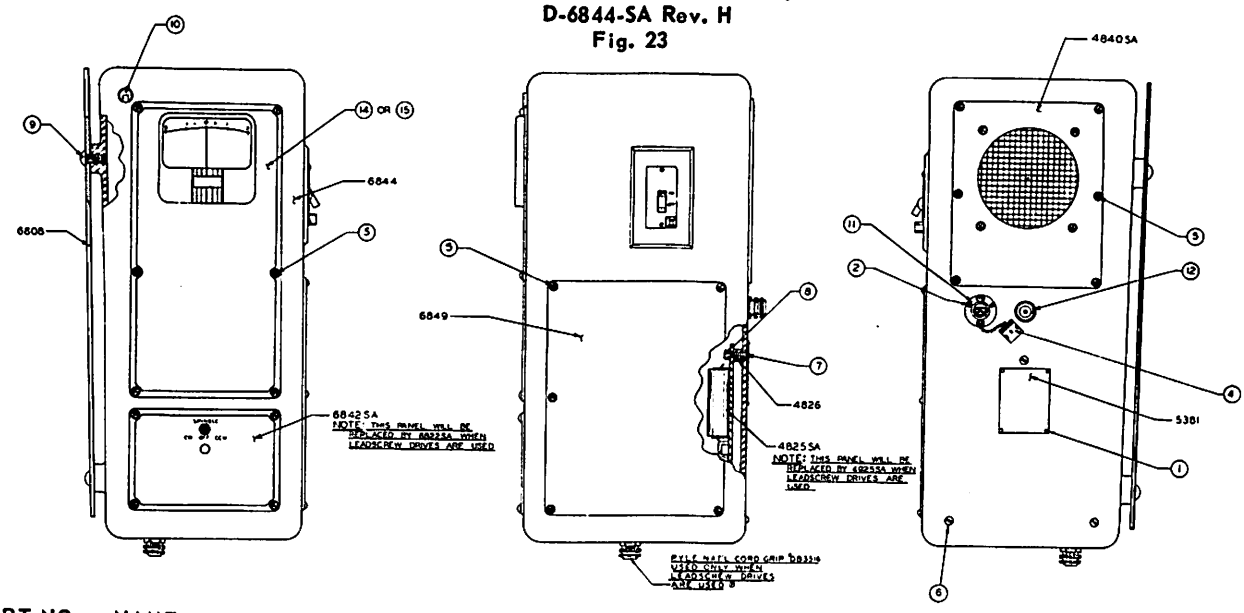




R. H. BOX SUBASSEMBLY

D-6844-SA Rev. H

Fig. 23



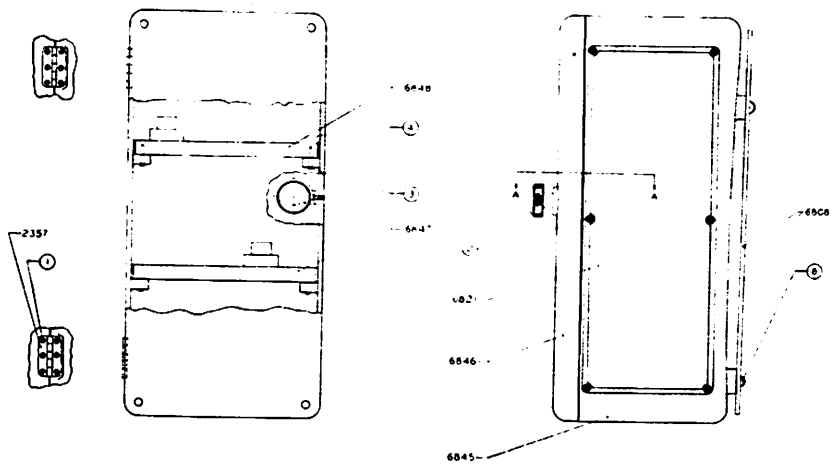
PART NO.	NAME
4825SA	Drive Panel Subassembly W/O Drive
4826	Spacer
4840SA	Fan Subassembly
4925SA	Drive Panel Sub-Assy.
5381	Electrical Nameplate
6808	Thermal Shield
6822SA	Traverse Panel Sub-Assy.
6842	Traverse Panel Sub-Assy W/O Drive
6844	R. H. Box
6849	R. H. Box Cover

ITEM NO.	NAME
1	#0 – 1/4 Type U Drive Screw
2	#5 – 40 x 3/8 Round Head Mach. Screw
3	
4	XLR-13 RC Dust Cap (Cannon)
5	#8 32 x 3/8 #SFSW8C6DB Panel Screw
6	#10 – 32 x 5/8 Oval Head Mach. Screw
7	#10 – 32 x 1" Oval Head Mach. Screw
8	#10 – 32 Nut
9	3/8 – 16 x 3/4 Button Head Cap Screw
10	Heyco 5P-1 Cord Grip
11	XLR-3-13 Receptacle (Cannon)
12	Pyle National Cord Grip #DB 3516
13	
14	Federal Amplifier (Option)
15	Cleveland Amplifier (Option)

L. H. BOX ASSEMBLY

D-6845-SA Rev. B

Fig. 24



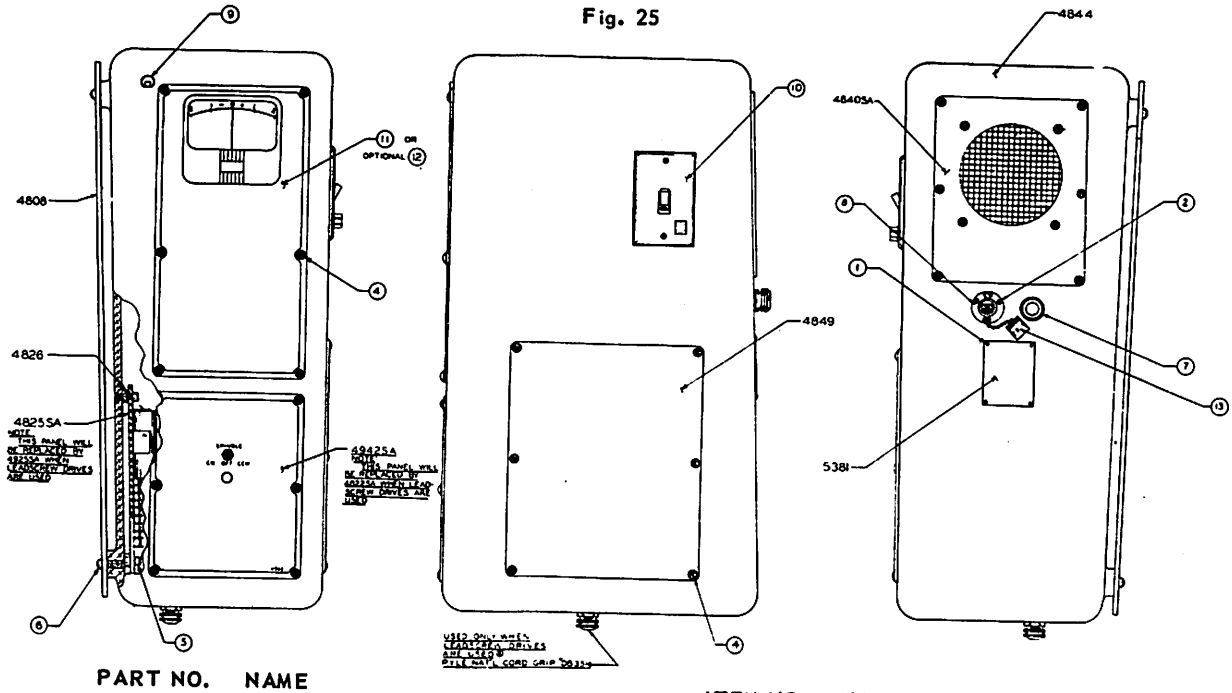
PART NO.	NAME
2357	Brass Hinge
4877	Latch Knob
4878	Latch Knob Bushing
4879	Latch Angle Strike
6821	Nameplate
6845	Left Hand Box
6846	Left Hand Box Cover
6847	Lower Shelf
6848	Top Shelf
6808	Thermal Shield

ITEM NO.	NAME
1	#8 – 32 x 3/8 Lg. Rd. Hd. Mach. Scr. (Gray Lacquer Fin.)
2	#8 – 32 x 3/8 SFSW8C6DB Panel Scr.
3	No. 6 x 7/8 Lg. Wood Screw
4	Spring Felt No. 124XN 5/8 Wide
5	#6 – 32 x 1/2 Lg. Hex. Sock. Cap Scr.
6	LTA-484 Door Lock Cam for Delta-Shaper No. 43-205
7	#8 – 32 x 1/2 Lg. Button Hd. Sock. Cap Scr.
8	#3/8 – 16 x 3/4 Lg. Button Hd. Sock. Cap Scr.

R. H. BOX SUB-ASSEMBLY

D-4844-SA Rev. J

Fig. 25



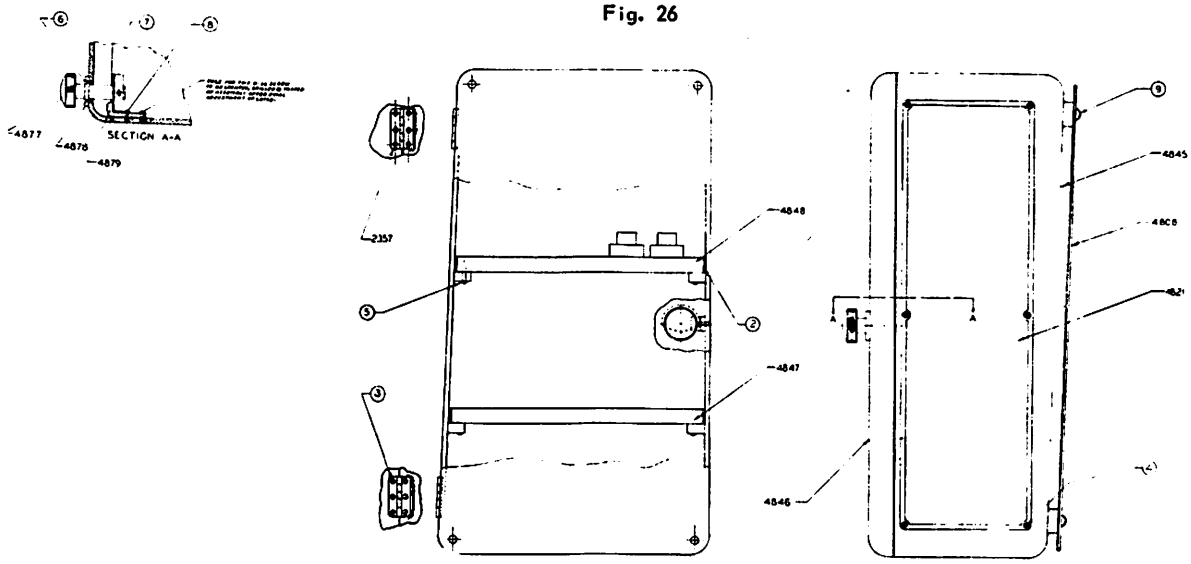
PART NO.	NAME
4808	Thermal Shield
4822SA	Traverse Panel Sub-Assy.
4825SA	Drive Panel Sub-Assy.
4826	Spacer
4840SA	Fan Subassembly
4844	R. H. Box
4849	R. H. Box Cover
4925SA	Drive Panel Sub-Assy W/O Drive
4942	Traverse Panel Sub-Assy. W/O Drive
5381	Electrical Nameplate

ITEM NO.	NAME
1	0 – 1/4 Type U Drive Screw
2	5 – 40 x 3/8 Round Head Mach. Screw
4	8 – 32 x 3/8 #SFSW8C6DB Panel Screw
5	10 – 32 x 3/4 Socket Head Cap Screw
6	3/8 – 16 x 3/4 Button Head Cap Screw
7	Pyle National Cord Grip #DB-3516
8	XLR-3 – 13 Receptacle (Cannon)
9	Heyco #3P-1 Cord Grip
10	A.B. Swt Bul. 600 Form 52 Cat. No. 600TKX10
11	Federal Amplifier (Option)
12	Cleveland Amplifier (Option)
13	XLR-13-RC Dust Cap (Cannon)

L. H. BOX ASSEMBLY

D-4845-SA Rev. G

Fig. 26



PART NO.	NAME
2357	Brass Hinge
4808	Thermal Shield
4821	Nameplate
4845	Left Hand Box
4846	Box Cover L.H.
4847	Lower Shelf
4848	Top Shelf
4877	Latch Knob
4878	Latch Knob Bushing
4879	Latch Angle Strike

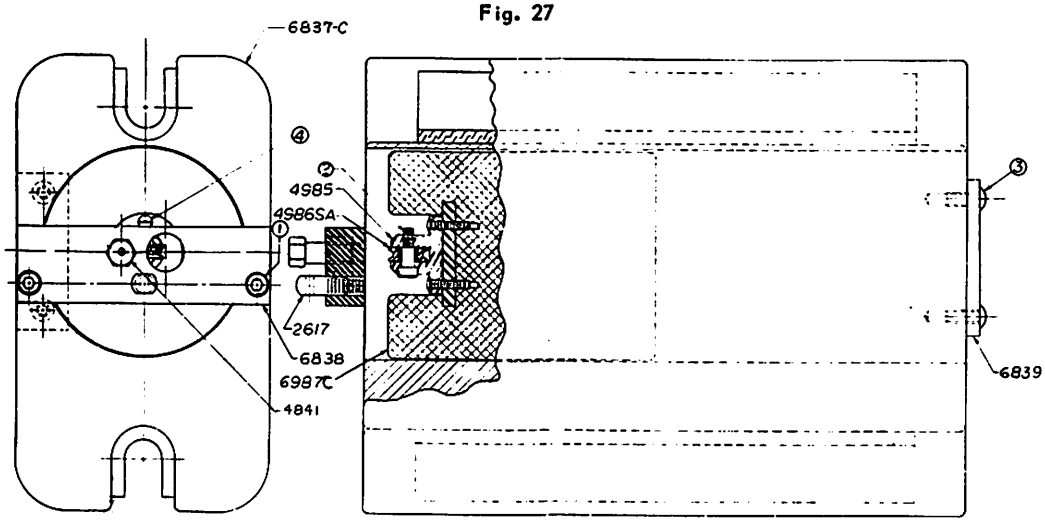
ITEM NO.	NAME
1	
2	Spring Felt No. 124XN 5/8 Wide
3	#8 – 32 x 3/8 Rd. Hd. Scr. (Gray Lacquer Finish
4	#8 – 32 x 1/2 Panel Screw (SFSW8C8DB)
5	No. 6 Wood Screw
6	#6 – 32 x 3/8 Hex. Socket Cap Screw
7	LTA-484 Door Lock Cam for Delta-Shaper No. 43-205
8	#8 – 32 x 1/2 Button Hd. Sock. Cap Screw
9	3/8 – 16 x 3/4 Button Hd. Sock. Cap Screw

MODEL 1½

COUNTERWEIGHT SUB-ASSEMBLY

C-6837-A Rev. B

Fig. 27



PART NO.	NAME
2617	Chain Terminal
4841	Cable Clamp
4985	Pulley Stud
4986	Pulley
6837C	Main Counterweight
6838	Support Bar
6839	Stop Plate
6987C	Quill Counterweight

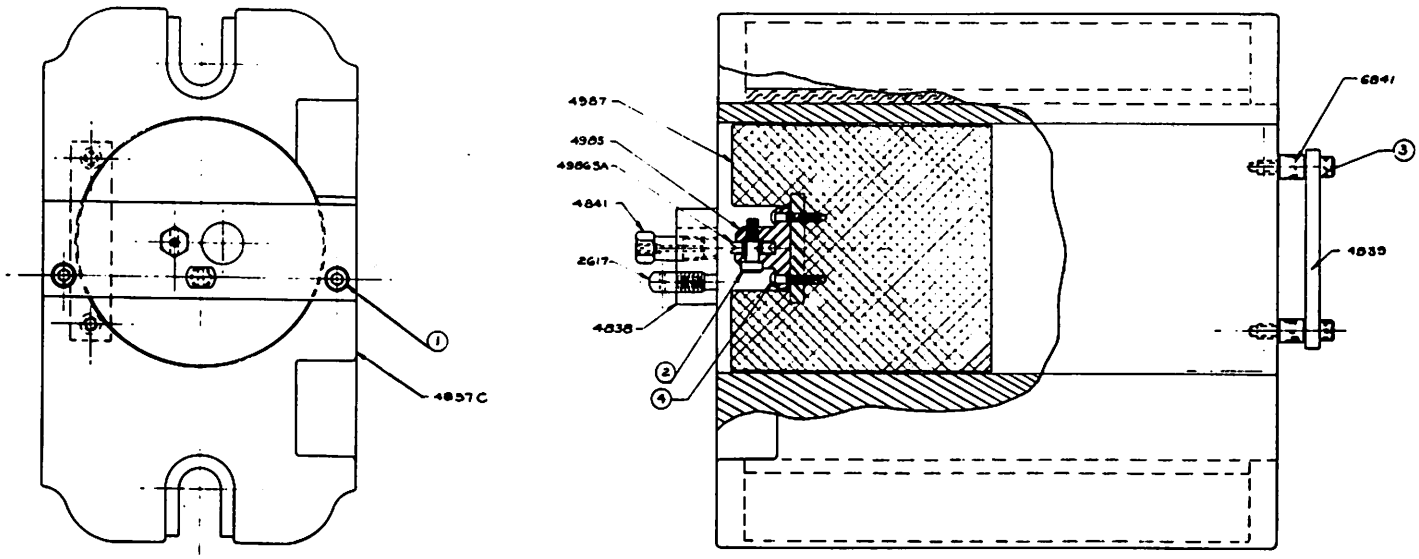
ITEM NO.	NAME
1	5/16 – 18 x 1" Lg. Sock. Hd. Cap Scr.
2	1/4 x 3/8 Shoulder Screw
3	1/4 – 20 x 1-1/4 Sock. Hd. Cap. Screw
4	#10 – 32 x 3/4 Round Head Screw

MODEL 3

COUNTERWEIGHT SUB-ASSEMBLY

D-4837-A

Fig. 28



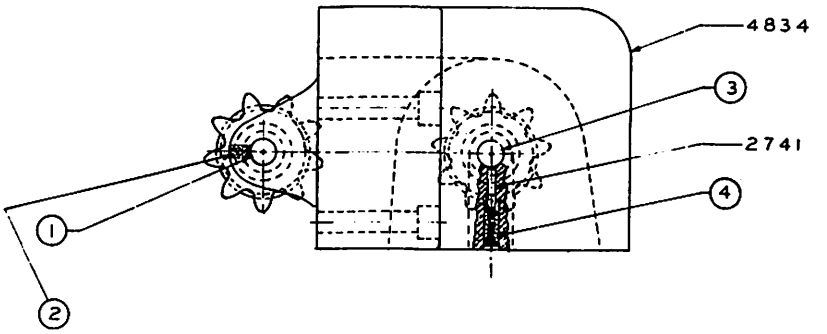
PART NO.	NAME
2617	Chain Terminal
4837C	Main Counterweight
4838	Support Bar
4839	Stop Plate
4841	Cable Clamp
4985	Pulley Stud
4986SA	Pulley
4987	Quill Counterweight
6841	Spacer-Stop Plate

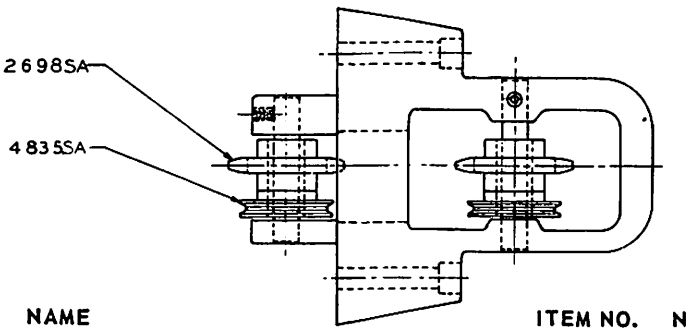
ITEM NO.	NAME
1	5/16 – 18 x 1" Lg. Sock. Hd. Cap Scr.
2	1/4 x 3/8 Hex. Sock. Shoulder Screw
3	1/4 – 20 x 5/8 Round Hd. Cap. Screw
4	#6 – 32 x 3/4 Round Hd. Cap. Screw

SPROCKET HOUSING SUB-ASSEMBLY

C-4834-SA

Fig. 29





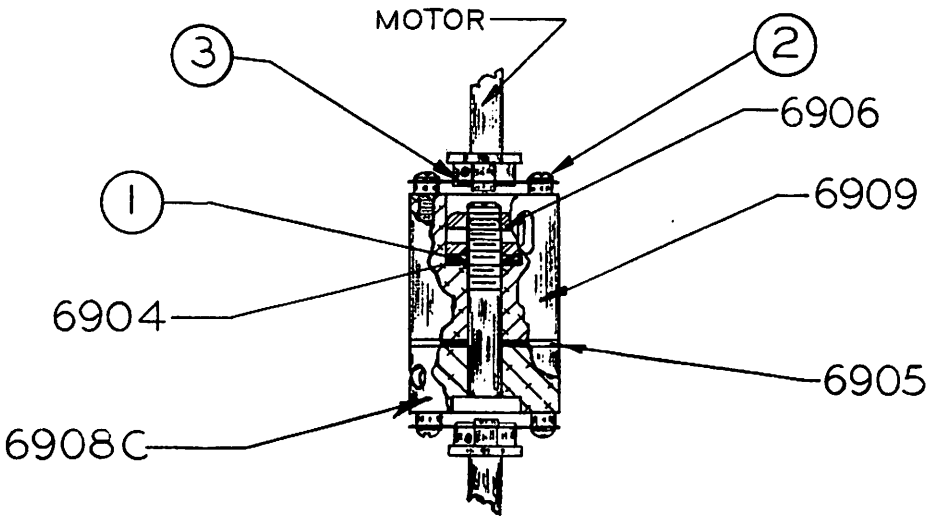
PART NO.	NAME
2698SA	Sprocket Assembly
2741	Binder Plug
4834	Column Sprocket Housing
4835SA	Pulley Assembly

ITEM NO.	NAME
1	3/8 x 2 Long. Std. Dowel
2	#8 – 32 x 5/16 Long. Sock. Set Scr.
3	3/8 x 2-1/2 Long. Std. Dowel
4	#8 – 32 x 1/2 Long. Sock. Set Scr. (Flat Point)

FRICTION CLUTCH ASSEMBLY

B-6909-A

Fig. 30



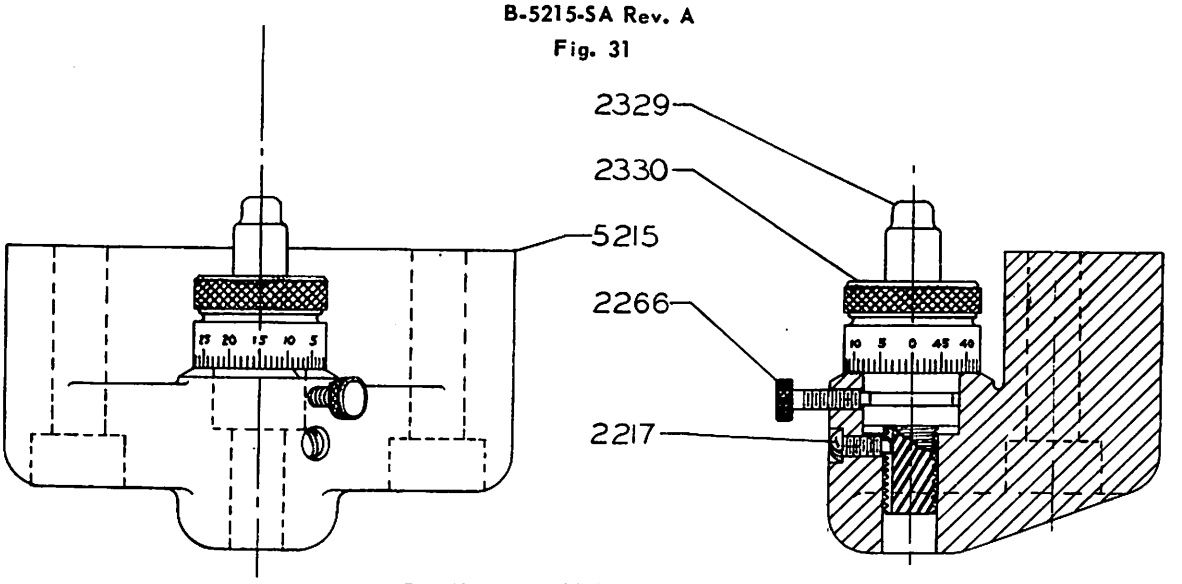
PART NO.	NAME
6904	Clutch Disc – Small
6905	Clutch Disc – Large
6906	Nut – Adjustment Shaft
6908C	Clutch Body Composite – Lower
6909	Clutch Body – Upper

ITEM NO.	NAME
1	Shakeproof Spring Washer Style #6 (#3515-10-01) Lindquist Supply
2	#2 – 56 x 1/4 Round Hd. Mach. Screw
3	Servo-Coupling Type "B" #51K (Renbrandt)

MICROMETER STOP ASSEMBLY

B-5215-SA Rev. A

Fig. 31

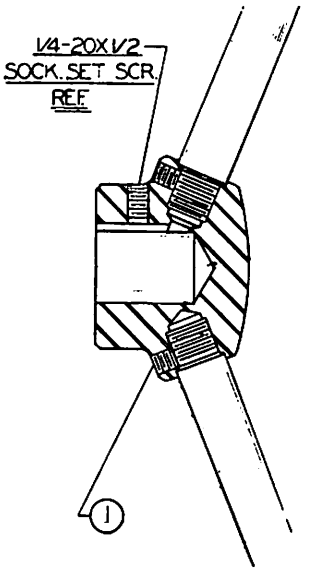


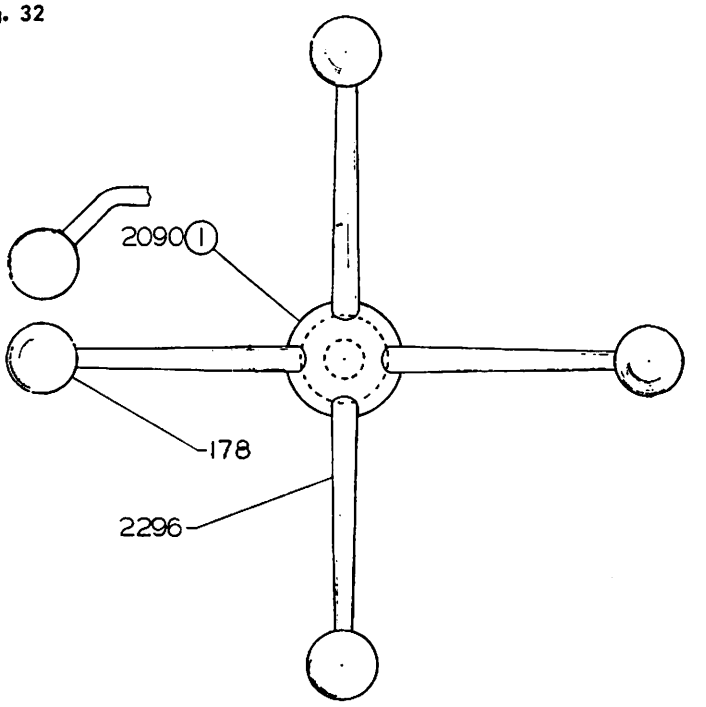
PART NO.	NAME
2217	Spindle Screw
2266	Thumb Screw
2329	Spindle
2330	Thimble
5215	Micrometer Stop Bracket

SPIDER SUB-ASSEMBLY

B-2090-SA

Fig. 32





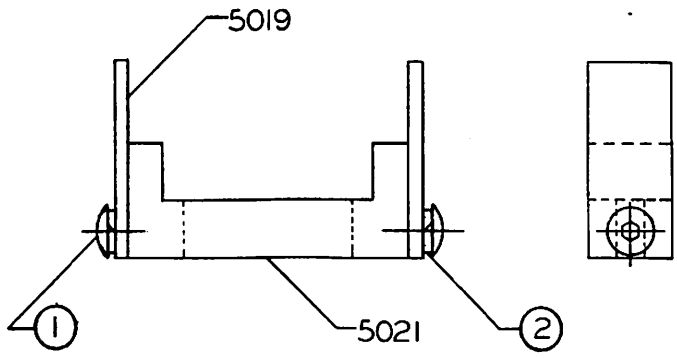
PART NO.	NAME
178	Control Ball
2090	Spider Hub
2296	Spider Spoke

ITEM NO.	NAME
1	1/4 – 20 x 3/8 Sock. Set Scr. Cone Point

TRAVEL STOP ASSEMBLY

A-5021-SA Rev. A

Fig. 33



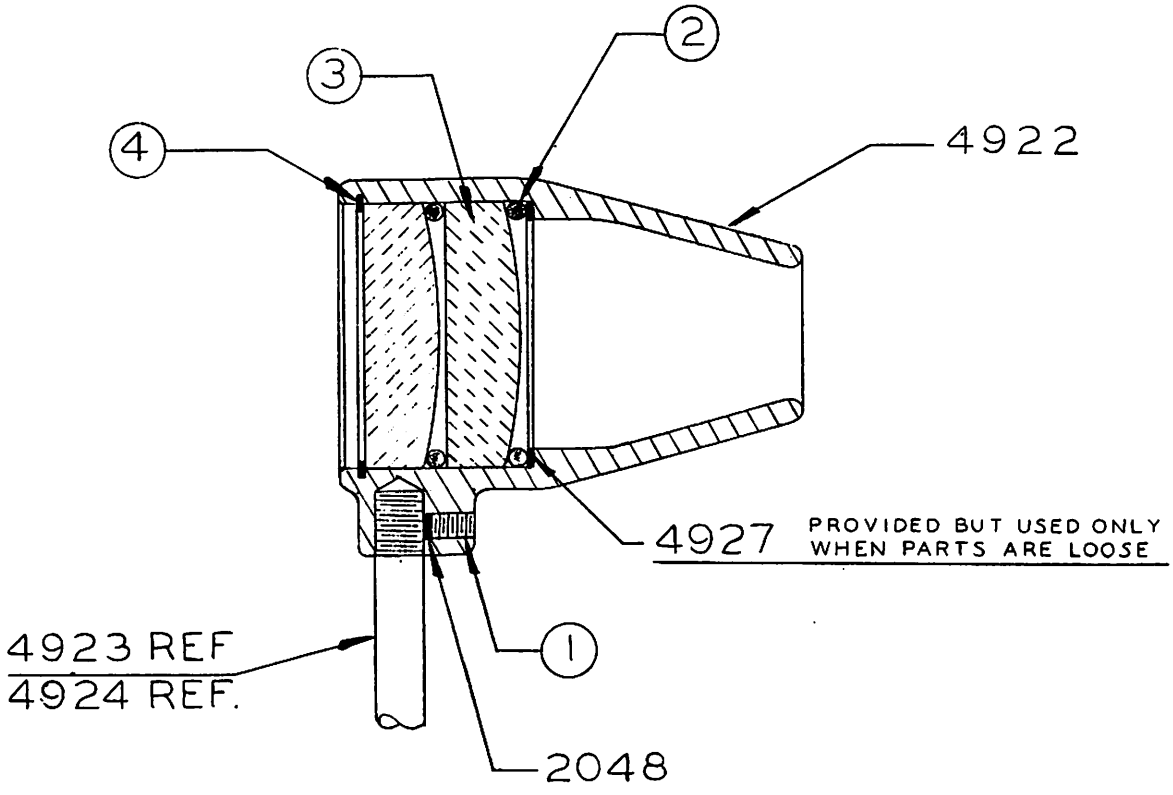
PART NO.	NAME
5019	Stop Spring
5021	Travel Stop Body

ITEM NO.	NAME
1	1/4–20x5/8 Long Button Head Sock. Cap Screw
2	Lock Washer for 1/4–20 Screw

MAGNIFIER SUB-ASSEMBLY

B-4922-SA Rev. A

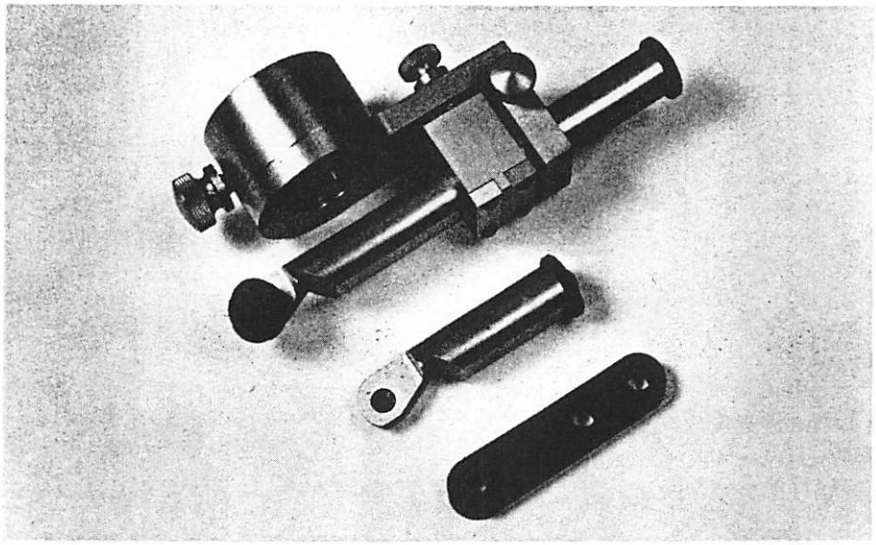
Fig. 34



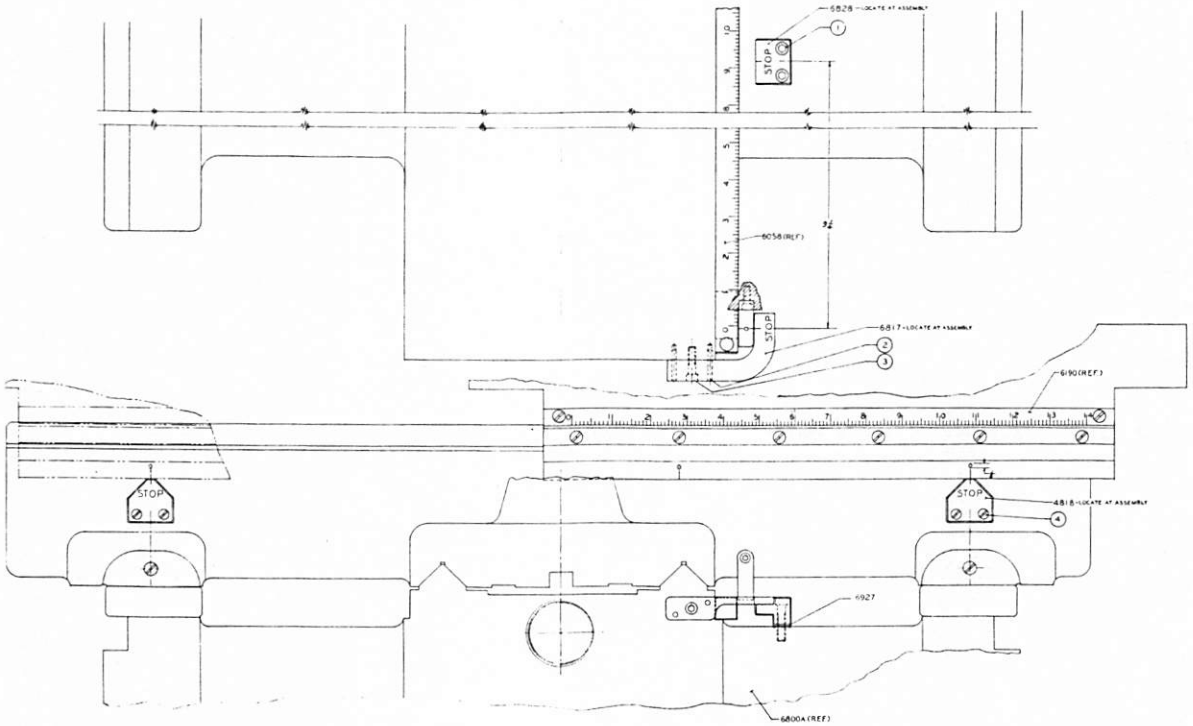
PART NO.	NAME
2048	Binder Plug
4922	Magnifier Housing
4927	Washer

ITEM NO.	NAME
1	10–32 x 1/4 Socket Set Screw
2	"O" Ring S-8-2 (AN6230-2)
3	A. Jaegers No. 1005 Coated Achromatic Lens
4	Waldes #5000-200

INDICATOR MOUNT ASSEMBLIES
No. 49090A
Fig. 35



MODEL 1½
LIMIT STOP INSTALLATION
D-6805-SA Rev. B
Fig. 36



PART NO.	NAME
6927	Washer
4818	Longitudinal Limit Marker
6817	Cross Limit Marker (Front)
6828	Cross Limit Marker (Inner)

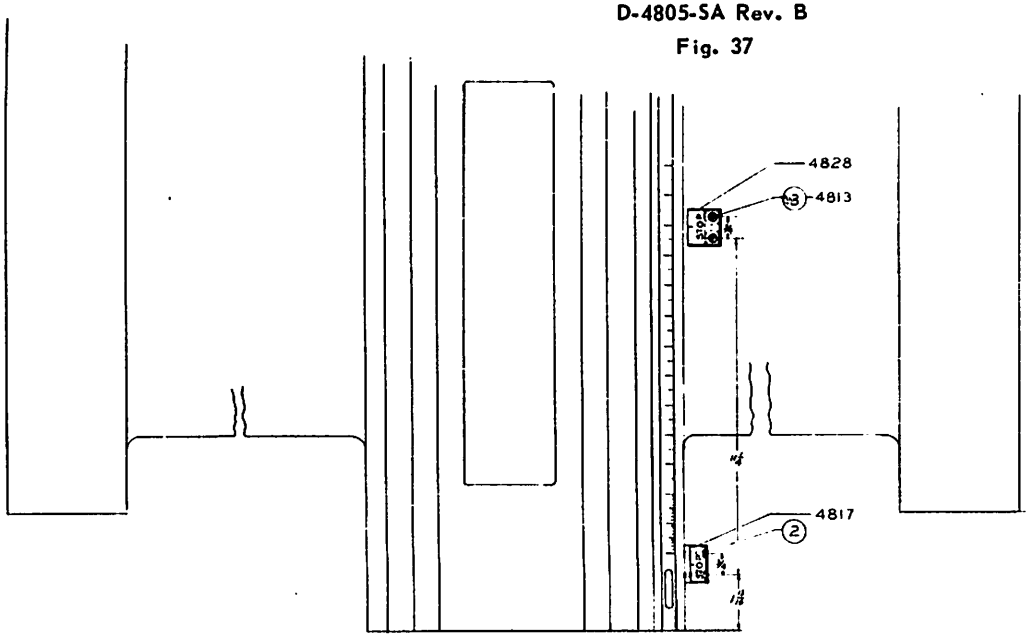
ITEM NO.	NAME
1	#10 – 32 x 1 Lg. Hex. Sock Hd. Cap Scr.
2	1/8 Dia. x 3/4 Long. Dowel Pin
3	#10 – 32 x 7/8 Lg. Hex. Sock. Hd. Cap Scr.
4	#8 – 32 x 1/2 Lg. Oval Hd. Mach. Scr.

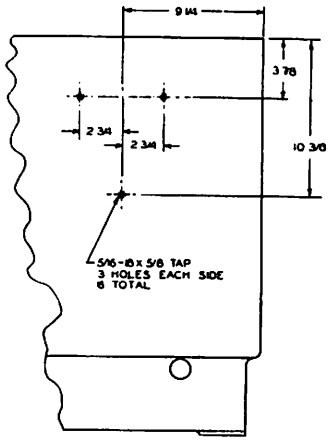
MODEL 3

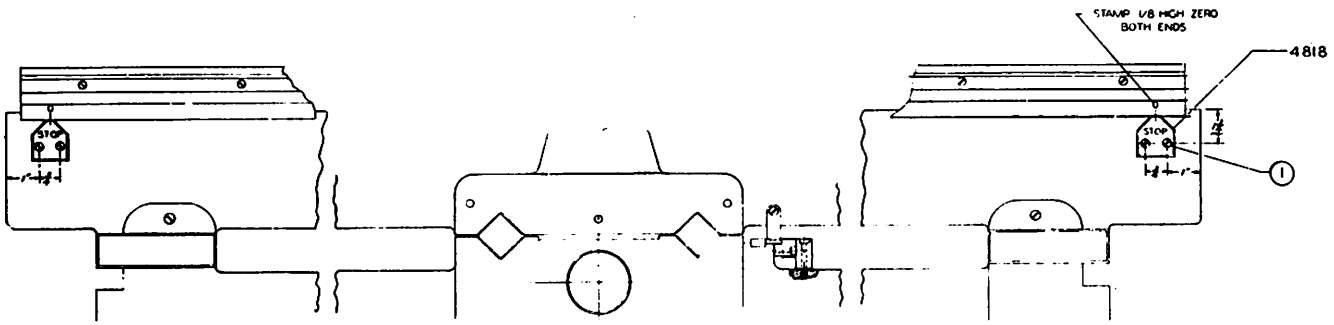
LIMIT STOP INSTALLATION

D-4805-SA Rev. B

Fig. 37



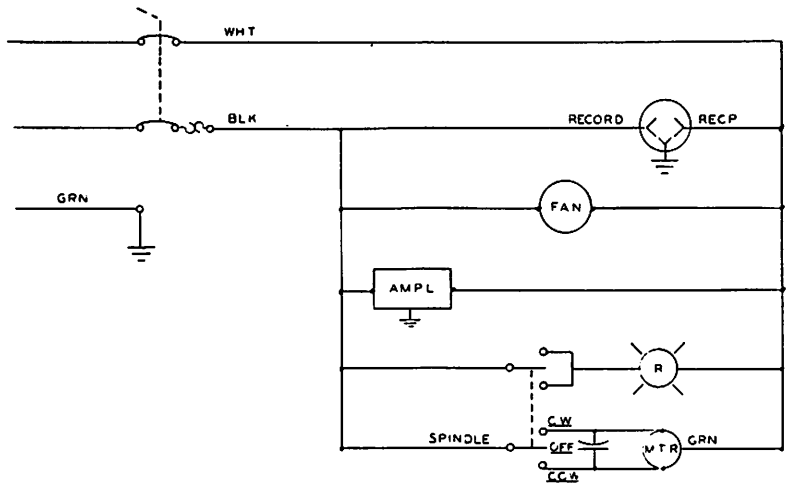




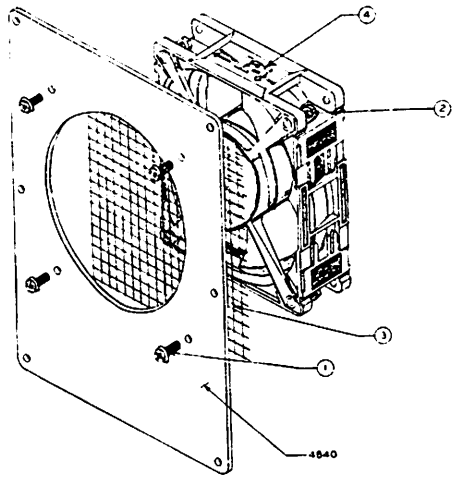
PART NO.	NAME
4813	Washer
4817	Cross Limit Marker
4818	Longitudinal Limit Marker
4828	Cross Limit Marker

ITEM NO.	NAME
1	#8 – 32 x 1/2 Lg. Oval Hd. Mach. Scr.
2	#10 – 32 x 7/8 Lg. Hex. Sock. Hd. Cap Scr.
3	#10 – 32 x 1-1/4 Lg. Hex. Sock. Hd. Cap Scr.

SCHEMATIC DIAGRAM
B-6824 Rev. A
Fig. 38



FAN SUBASSEMBLY
C-4840-SA Rev. A
Fig. 39



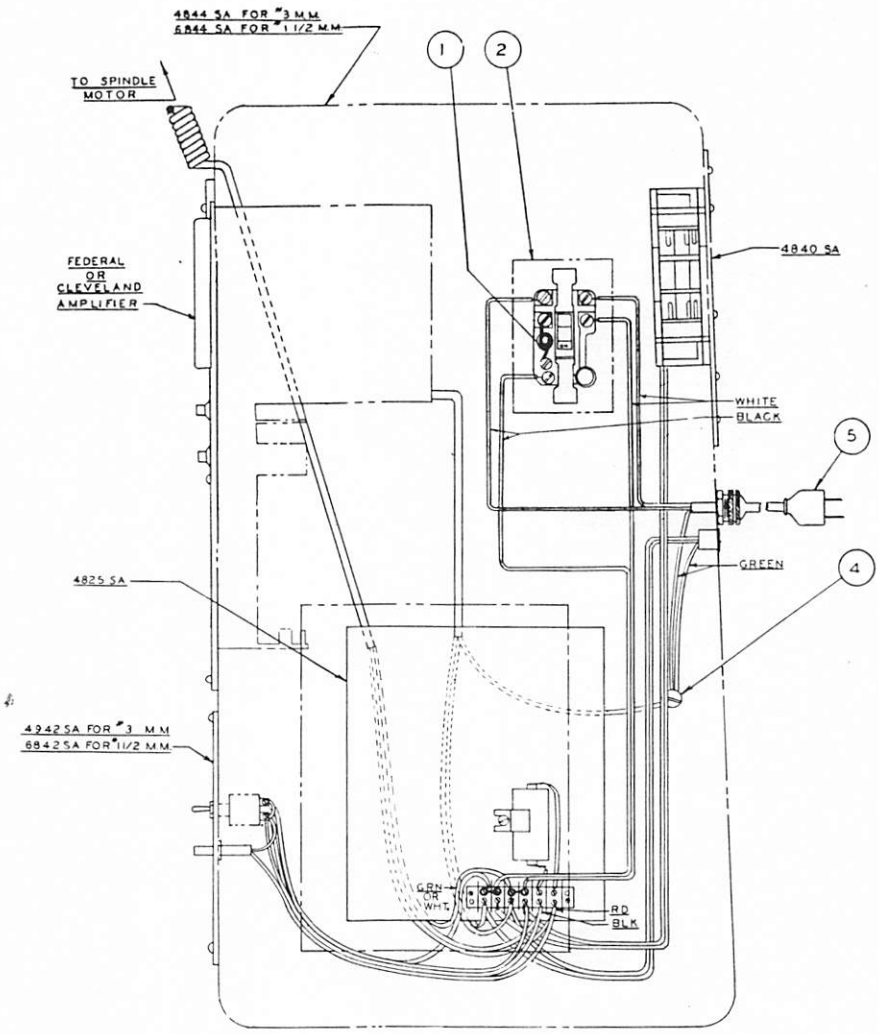
PART NO.	NAME
4840	Fan Plate

ITEM NO.	NAME
1	#8 – 32 x 3/4 SFSW 8C12DB panel screw
2	#8 – 32 nut
3	Screen – 1/4 grid – 5 x 5 sq. (paint gray)
4	Rotron venturi whisper fan

ELECTRICAL INSTALLATION

C-4827-A

Fig. 40



PART NO.	NAME
4825A	Drive panel sub-assembly w/o drive
4840SA	Fan sub-assembly

ITEM NO.	NAME
1	Heater element, Allen-Brad. Bul. 600 type P-26
2	Switch, Allen-Brad. Bul. 600 form 52 cat. no. 600TK X109
4	#8 – 32 x 3/8 binding head screw
5	6 ft. cord, 3 wire 18 SJO with molded plug

BASE, TABLE AND CROSS SLIDE ASSEMBLY

PART NO.	NAME
17	Locking Plug
75	Washer
178	Control Ball
1282	Adapter
2007C	Handwheel
2008	#1 Rockwood Handwheel Handle
2048	Binder Plug
2059	Handwheel Binder Knob
2202	Chip Wiperfelt Cover
2298	Handwheel Binder Knob Washer
2331	Thrust Collar
2336	Scale Clamp Screw
2337	Long Clamp Handle
2350	Zero Clamp Screw Washer
2415	Handwheel Binder Knob Washer Pin
3308	3/8 – 16 Hex. Nut
3309	7/8 O.D. x 25/64 I.D. x 3/32 Thk. Washer
4810	Lead Screw Dial
4814	Vernier Dial (Table)
4815	Vernier Dial (Cross Slide)
4832	Dial Clamp Knob
4922SA	Magnifier Sub-Assem.
4923	Long Magnifier Arm
4924	Short Magnifier Arm
4926	Vernier Adjusting Plate
5012	Lead Screw Adjusting Collar
5018	Washer (Under Travel Stop Body #5021)
5019	Stop Spring
5020	Travel Stop Bumper
5021	Travel Stop Body
5024	Table Clamp Screw Washer
5025	Vernier Spring Washer
5030	Washer (For Lead Screw Nut)
5033	Cross Slide Clamp Screw (L.H.)
5034	Cross Slide Clamp Screw (R.H.)
5039	Left Hand Chip Pan & Oil Reservoir
5040	Right Hand Chip Pan
5042	Oil Filler Cap
5048	Table Clamp Plug
5052	Cross Clamp Washer
5054	Clamp Rod Strap
5060	Table Clamp Screw
5203	Clamp Handle Body
5331	Clamp Handle Washer
5333	Cross Zero Bracket
5335	Clamp Handle
5338	Longitudinal Zero Bracket
6001	Base
6004	Table Lead Screw
6005	Cross Slide Lead Screw
6015	Lead Screw Nut
6018	Washer (Under Travel Stop Body #5021)
6022	Cross Slide
6023	Table
6026	Cross Slide Chip Guard (Lower)
6027	Base Chip Guard
6050	Table Clamp (Rear)
6051	Table Clamp (Front)
6053	Clamp Rod
6055	Table Clamp Pad
6058	Cross Slide Scale
6077	Flat Way
6121	Rear Cover
6182	Way Guard & Felt Holder
6190	Table Scale
6196	Table Clamp Blade
6199	Cross Slide Felt Holder
6200	Table Felt Holder
6201	Chip Wiper Felt
6204	Cross Slide Clamp
6321	Felt Wiper (Female Vee)
6333	Stud (Scale Clamp Screw)
6334	Washer (Scale Clamp Screw)
6335	Scale Support Screw (Cross Slide)
6336	Scale Clamp Screw (Cross Slide)
6337	Scale Knob
6338	Clamp Handle Stop Pin
6352A	Cross Slide Lubrication System
6354A	Table Lubrication System
6805SA	Limit Stop Installation
6813C	Drain Plug Composite
60006SA	Ball Retainer Sub-Assembly
68011C	Dial Housing (Table)
68029C	Dial Housing (Cross Slide)

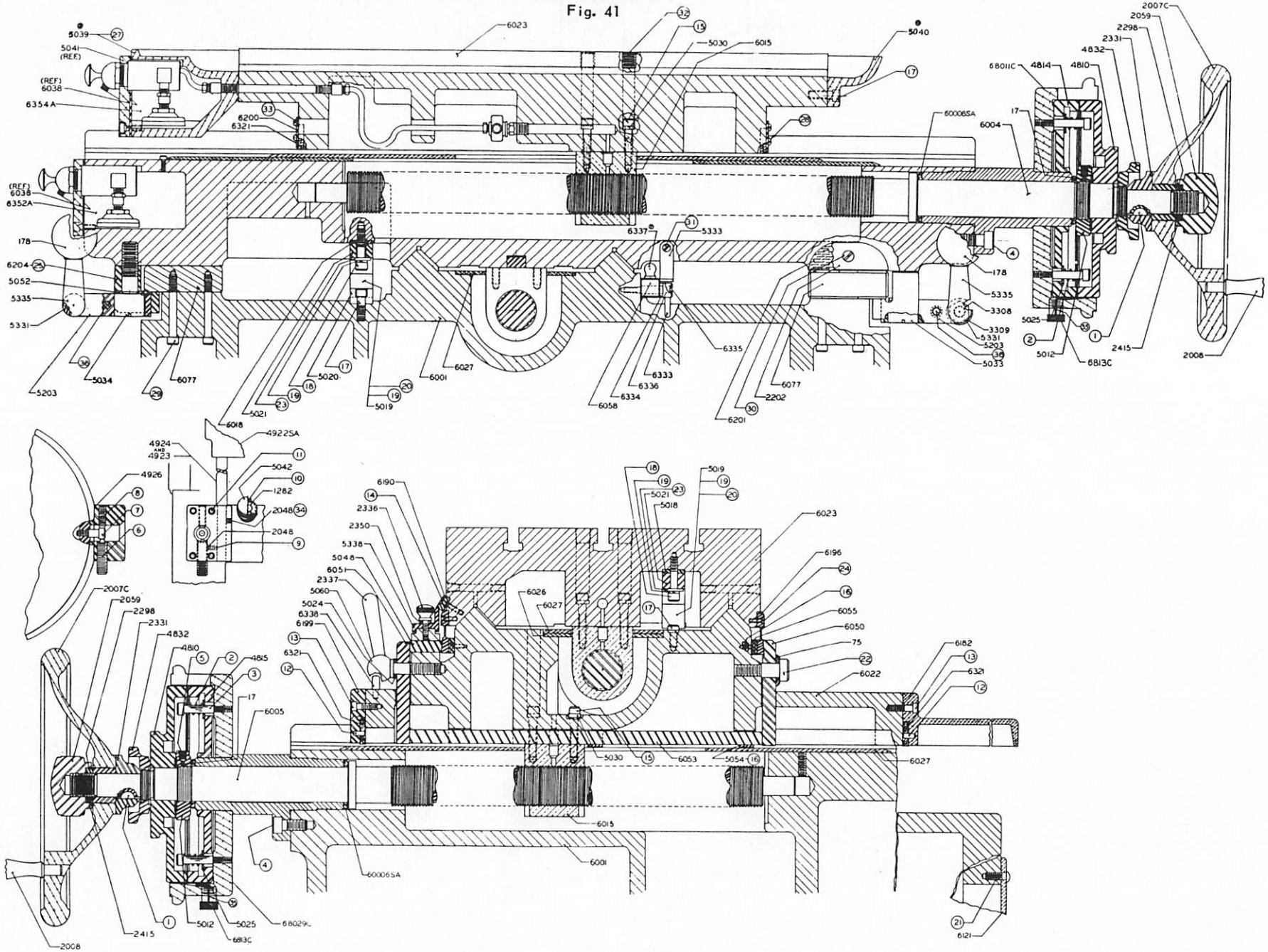
ITEM NO.	NAME
1	#2 Woodruff Key
2	Hardware Prod. Spring .047 x 3/8 I.D. x 3/4 O.D.
3	1/4 x 1" Lg. Shoulder Screw.
4	3/8 – 16 x 7/8 Sock. Hd. Cap Scr.
5	1/4 – 28 x 1/4 Lg. Sock. Set Scr.
6	Vlier #S-58
7	1/4 x 3/8 Lg. Shoulder Screw
8	1/4 – 20 x 3/4 Lg. Oval Pt. Sock. Set Scr.
9	10 – 32 x 1/4 Lg. Sock. Set Scr.
10	E. F. Houghton "O" Ring #5-7-9
11	6 – 32 x 1 Lg. Sock. Hd. Cap Scr.
12	.156 Dia. x 5/16 Lg. Roll Pin
13	10 – 32 x 5/8 Lg. Sock. Hd. Cap Scr.
14	8 – 32 x 5/8 Lg. Oval Hd. Mach. Scr.
15	1/4 – 20 x 1-1/2 Lg. Sock. Hd. Cap Scr.
16	6 – 32 x 3/8 Lg. Flat Hd. Mach. Scr. (Soft)
17	1/4 – 20 x 5/8 Lg. Sock. Hd. Cap Scr.
18	1/4 – 20 x 1-1/4 Lg. Sock. Hd. Cap Scr.
19	1/4 Lockwasher
20	1/4 – 20 x 5/8 Lg. Button Hd. Cap Scr.
21	1/4 – 20 x 1/2 Lg. Sock. Hd. Cap Scr.
22	1/2 x 9/16 Stripper Bolt – Special
23	1/4 SAE Std. Steel Washer
24	6 – 32 x 7/16 Lg. Oval Hd. Mach. Scr.
25	1/2 – 13 x 1-3/4 Lg. Sock. Hd. Cap Scr.
26	10 – 32 x 1/2 Lg. Sock. Hd. Cap Scr.
27	1/4 – 20 x 3/4 Lg. Sock. Hd. Cap Scr.
28	6 – 32 x 1/2 Lg. Rd. Hd. Mach. Scr.
29	1/4 – 20 x 1-3/4 Lg. Sock. Hd. Cap Scr.
30	10 – 32 x 5/8 Lg. Oval Hd. Mach. Scr.
31	8 – 32 x 1/2 Lg. Fillister Hd. Mach. Scr.
32	7/16 – 20 x 1/2 Lg. Sock. Set Scr.
33	6 – 32 x 3/8 Lg. Rd. Hd. Mach. Scr.
34	10 – 32 x 3/16 Lg. Sock. Set Scr.
35	Pipe Cleaner 1-1/8 Lg.
36	1/4 – 20 x 1 Lg. Sock. Hd. Cap Scr.

MODEL 1½

BASE, TABLE AND CROSS SLIDE ASSEMBLY

E-6800-A Rev. 1

Fig. 41



BASE, TABLE AND CROSS SLIDE ASSEMBLY

PART NO.	NAME
75	Washer
178	Control ball
338	Stop button
2336	Scale clamp screw
2337	Long clamp handle
2350	Long zero clamp screw washer
3308	3/8 - 16 hex nut
3309	7/8 O.D. x 25/64 I.D. x 3/32 washer
5001	Base
5015	Leadscrew nut
5016	Leadscrew nut dowel
5018	Washer – under stop assemblies 5021SA
5020	Travel stop bumper
5021SA	Travel stop S.A.
5022	Cross slide
5023	Table
5024	Table clamp screw washer
5026	Cross slide chip guard (lower)
5027	Base chip guard
5030	Washer for leadscrew nut
5033	Cross slide clamp screw left H. th'd
5034	Cross slide clamp screw right H. th'd
5039	L.H. chip pan
5040	R.H. chip pan – see field of drawing
5044	Washer for cross scale
5047	Fiber shipping guard (see Note 1)
5048	Table clamp plug
5050	Table clamp – rear
5051	Table clamp – front
5052	Cross clamp washer
5053	Clamp rod
5054	Clamp rod strap
5055	Table clamp pad
5058	Cross slide scale
5060	Table clamp screw
5075	Cross slide 90° vee way
5076	Base 90° vee way
5077	Flat way
5121	Back cover – for 3JG
5182	Way guard
5190	Table scale
5196	Table clamping blade
5199C	Felt holder composite
5200C	Table felt holder
5201	Chip wiper felt
5202	Chip wiper felt cover
5203	Clamp handle body
5204	Cross slide clamp
5221	Back cover – for 3JB & 3MM
5258	Hold down cross scale
5321	Felt wiper female vee
5331	Clamp handle washer
5333	Cross zero bracket
5334	Cross scale bracket
5335	Clamp handle
5336	Scale clamp screw
5338	Longitudinal zero bracket
5352A	Cross slide lubrication system
5354A	Table Bijur lubrication system

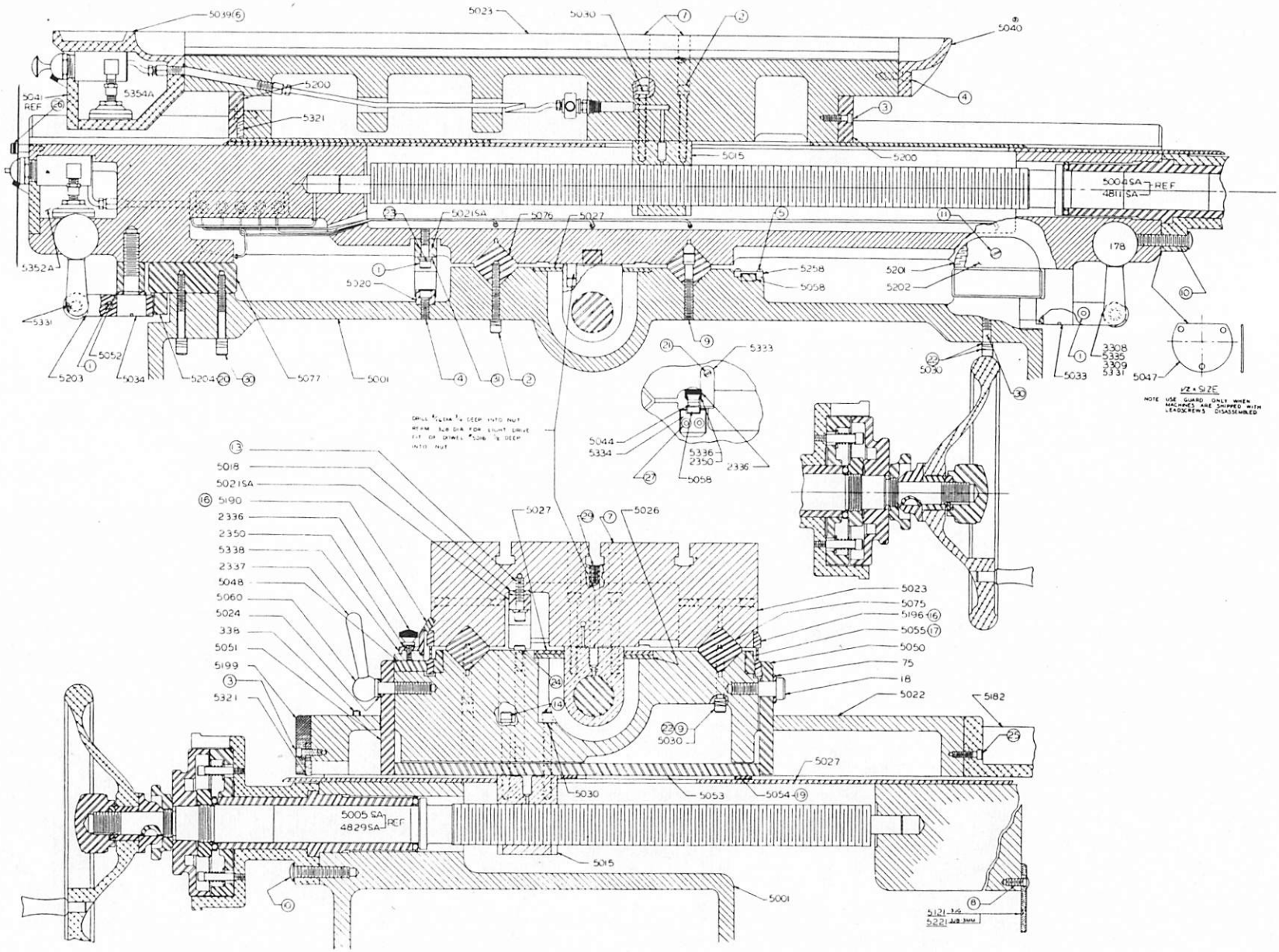
ITEM NO.	NAME
1	1/4-20 x 1 lg soc. hd. cap scr.
2	1/4-20 x 2 lg soc. hd. cap scr.
3	#10 - 32 x 5/8 lg soc. hd. cap scr.
4	1/4 - 20 x 5/8 lg soc. hd. cap scr.
5	#6 - 32 x 3/8 lg rd. hd. machine scr.
6	1/4 - 20 x 3/4 lg soc. hd. cap scr.
7	7/16 - 20 x 1/2 lg soc. hd. set scr.
8	1/4 - 20 x 1/2 lg button hd. soc. cap scr.
9	1/4 - 20 x 1-5/8 lg. soc. hd. cap scr.
10	3/8 - 16 x 1½ lg. button hd. sock. cap scr.
11	#10 - 32 x 5/8 lg. oval hd. cap scr.
12	
13	1/4 - 20 x 1¼ lg. soc. hd. cap scr.
14	1/4 - 20 x 2½ lg. soc. hd. cap scr.
15	
16	#8 - 32 x 1/2 lg. oval hd. cap scr.
17	#6 - 32 x 5/16 lg. soc. hd. cap scr. (special)
18	1/2 dia. x 9/16 lg. stripper bolt (special) #3/8 - 16
19	#6 - 32 x 3/8 lg. flat hd. cap scr.
20	1/2 - 13 x 1¾ lg. soc. hd. cap scr.
21	#8 - 32 x 1/2 fill. hd. scr.
22	1/4 double coil .062 x .047 lock washers
23	Lockwasher for 1/4 - 20 scr.
24	1/4 - 20 x 1/2 lg. soc. hd. cap scr.
25	#10 - 32 x 7/8 lg. soc. hd. cap scr.
26	#10 - 24 stripper bolt 1/4 dia. x 3/8 lg.
27	#10 - 32 x 1 lg. soc. hd. cap scr.
28	Loctite sealant grade 'AVV' on Harden Way scr.'s
29	#10 - 32 x 3/8 lg. soc. set scr.
30	1/4 - 20 x 2¼ lg. soc. hd. cap scr.
31	1/4 standard SAE washer

MODEL 3

BASE, TABLE AND CROSS SLIDE ASSEMBLY

E-5000-A Rev. J

Fig. 42

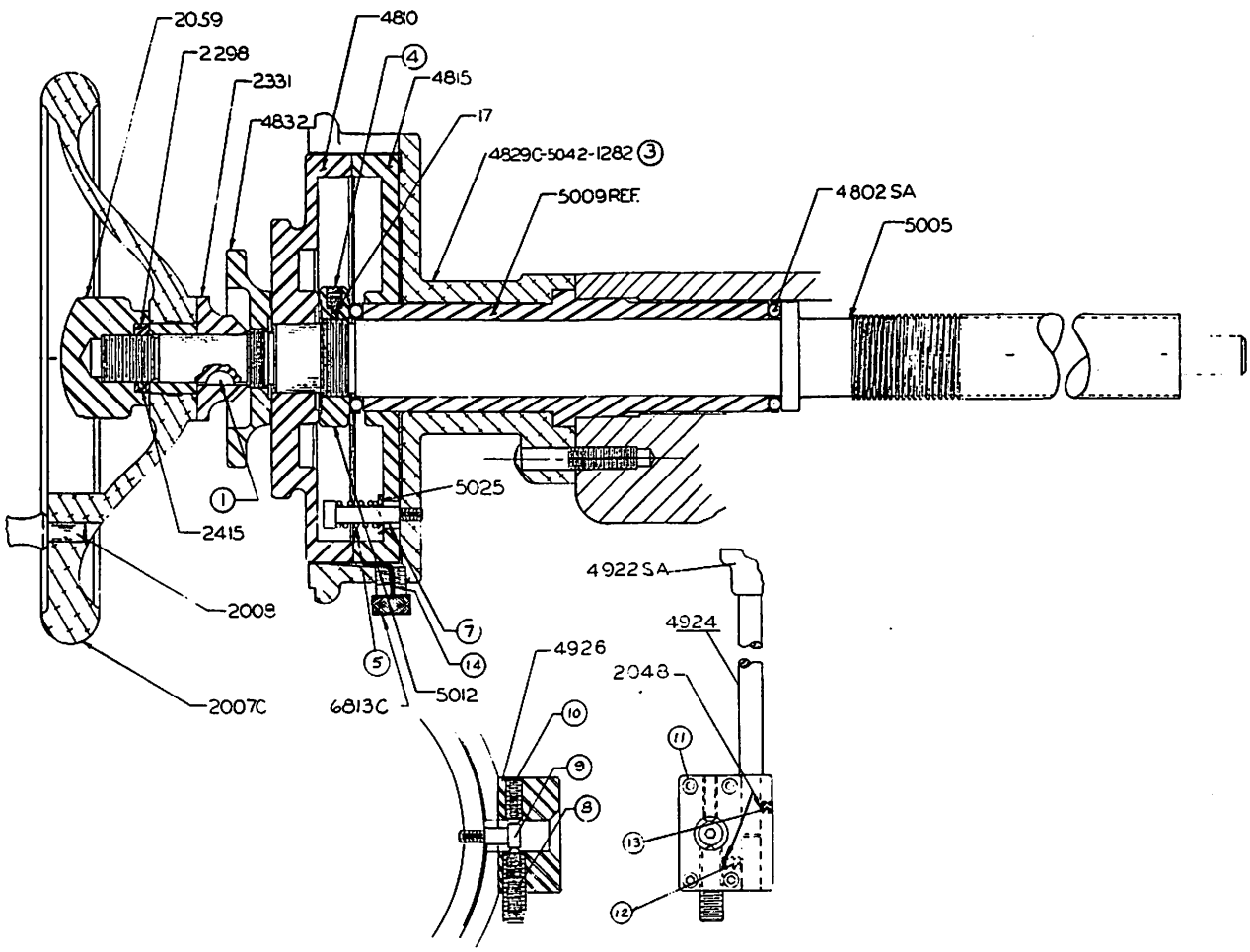


MODEL 3

CROSS SLIDE LEAD SCREW SUB-ASSEMBLY

C-4829-SA Rev. G

Fig. 43



PART NO.	NAME
17	Locking Plug
1282	Adapter
2007C	Handwheel
2008	#1 Rockwood Handwheel Handle
2048	Binder Plug
2059	Handwheel Binder Knob
2298	Handwheel Binder Knob Washer
2331	Thrust Collar
2415	Handwheel Binder Knob Washer Pin
4802SA	Thrust Bearing Sub Assembly
4810	Leadscrew Dial
4815	Vernier Dial
4829C	Dial Housing
4832	Dial Clamp Knob
4922SA	Magnifier Sub Assembly
4924	Short Magnifier Arm
4926	Vernier Adj. Plate
5005	Table Screw
5012	Lead Screw Adjusting Collar
5025	Vernier Spring Washer
5042	Filler Cap
6813C	Drain Plug

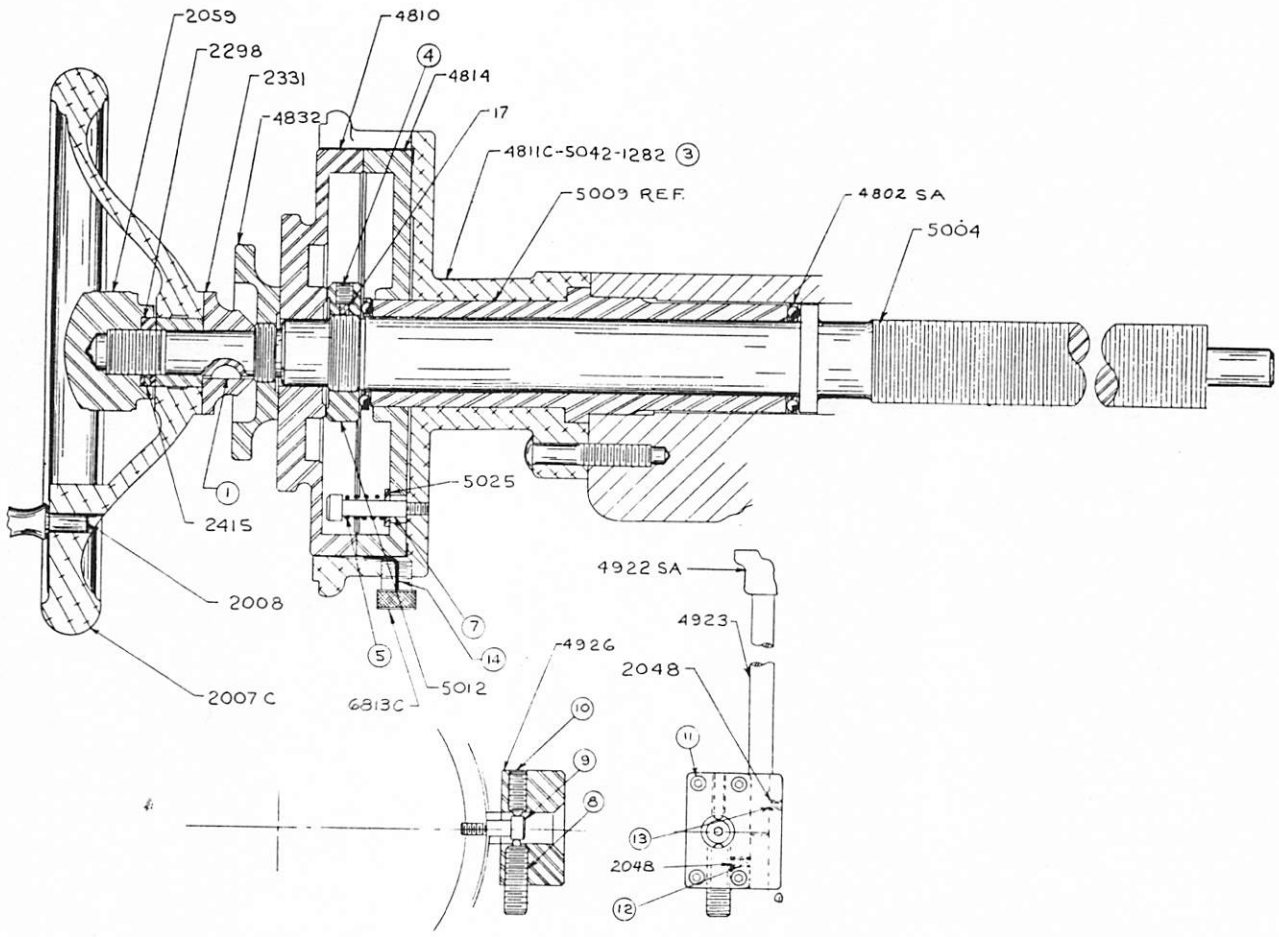
ITEM NO.	NAME
1	#2 Woodruff Key
3	#S-7-9 "O" Ring E. F. Houghton
4	1/4-28 x 1/4 Long Sock. Set Screw
5	Hardware Prod. Spring .047 x 3/8 x 3/4
7	1/4 x 1 Shoulder Screw
8	Vlier S-58
9	1/4 x 3/8 Shoulder Screw
10	1/4 x 3/4 Oval Pt. Socket Set Screw
11	6 – 32 x 1 Socket Cap Screw
12	10 – 32 x 1/4 Socket Set Screw
13	10 – 32 x 3/16 Socket Set Screw
14	Pipe Cleaner 1-1/8 Long.

MODEL 3

TABLE LEAD SCREW SUB-ASSEMBLY

C-4811-SA Rev. G

Fig. 44



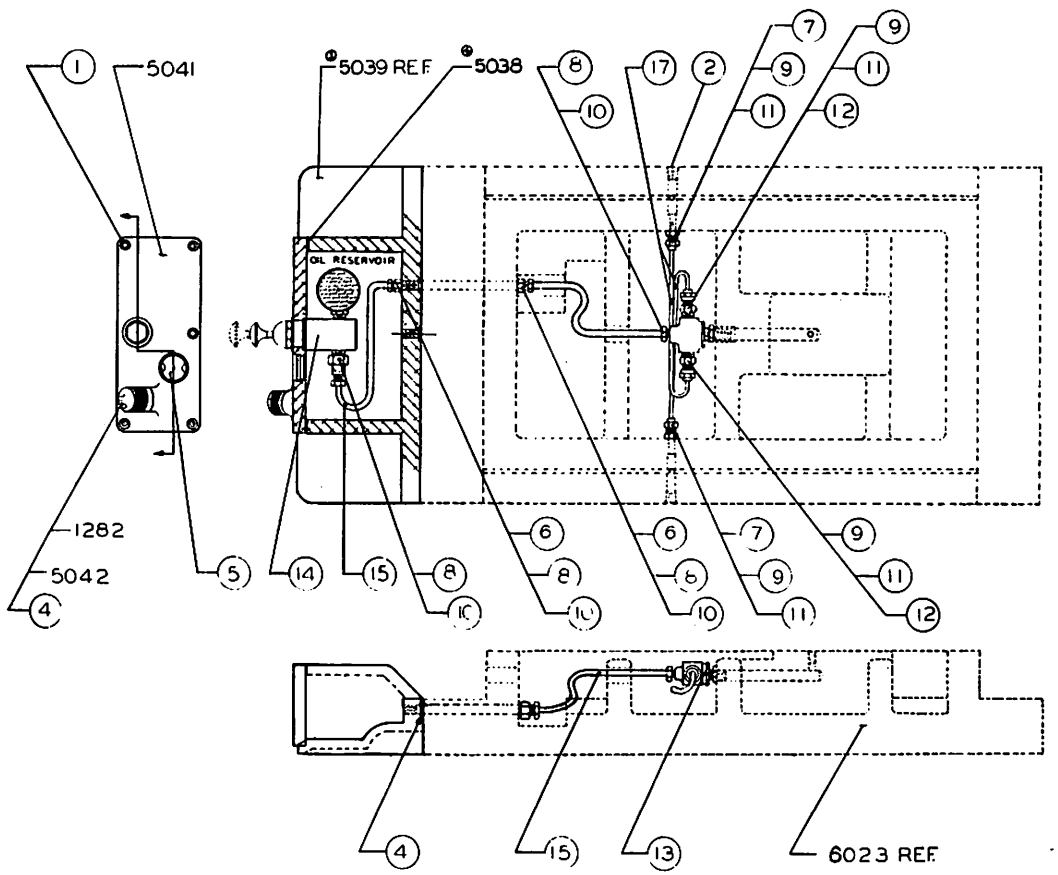
PART NO.	NAME
17	Locking Plug
1282	Adapter
2007C	Handwheel
2008	#1 Rockwood Handwheel Handle
2048	Binder Plug
2059	Handwheel Binder Knob
2298	Handwheel Binder Knob Washer
2331	Thrust Collar
2415	Handwheel Binder Knob Washer Pin
4802SA	Thrust Bearing Sub. Assembly
4810	Leadscrew Dial
4811	Dial Housing (Table)
4814	Table Vernier Dial
4832	Dial Clamp Knob
4922SA	Magnifier Sub Assembly
4923	Long Magnifier Arm
4926	Vernier Adj. Plate
5004	Table Screw
5012	Lead Screw Adjusting Collar
5025	Vernier Spring Washer
5042	Filler Cap
6813C	Drain Plug

ITEM NO.	NAME
1	#2 Woodruff Key
3	#S-7-9 "O" Ring E. F. Houghton
4	1/4 – 28 x 1-1/4 Long Sock. Set Screw
5	Hardware Prod. Spring .047 x 3/8 x 3/4
7	1/4 x 1 Shoulder Screw
8	Vlier S-58
9	1/4 x 3/8 Shoulder Screw
10	1/4 x 3/4 Oval Pt. Socket Set Screw
11	6 – 32 x 1 Socket Cap Screw
12	10 – 32 x 1/4 Socket Set Screw
13	10 – 32 x 3/16 Socket Set Screw
14	Pipe Cleaner 1-1/8 Long

MODEL 1½

TABLE BIJUR LUBRICATING SYSTEM ASSEMBLY

D-6354-A Rev. B
Fig. 45



PART NO.	NAME
1282	Adapter
5038	Gasket
5041	Oil Reservoir Cover Plate
5042	Filler Cap

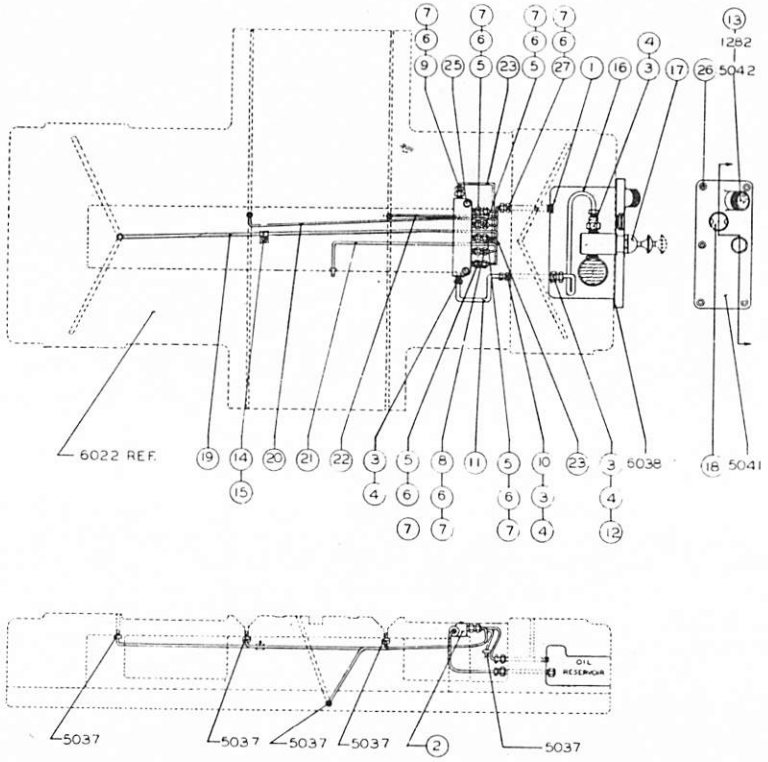
ITEM NO.	NAME
1	#10 – 32 x 1/2 Sock. Head Cap Screw
2	Tapered Pipe Plug 1/16 – 27
4	E. F. Houghton "O" Ring S-7-9
5	Bijur Window Unit Std. Type B-4900
6	Bijur Straight Adapter B-4312 L" = 3/4
7	Bijur Straight Adapter B-4452
8	Bijur Compression Sleeve B-1061
9	Bijur Compression Sleeve B-3313
10	Bijur Compression Bushing B-1371
11	Bijur Compression Nut B-3610
12	Bijur Meter-Unit F.J.D. – 2 B-3776
13	Bijur Meter Unit F.T.B.–0, B-1077
14	Bijur Lubricator Unit L.P.M. B-6586 (Special)
15	Bijur Brass Tubing No. 5B25 5/32 O.D. 7" Long.
17	Bijur Copper Tubing No. 3C22 3/32 O.D. 6-1/2" Long.

MODEL 1½

CROSS SLIDE LUBRICATING SYSTEM ASSEMBLY

D-6352-A Rev. A

Fig. 46



PART NO.	NAME
1282	Adapter
6038	Gasket
5037	Drive Bushing
5041	Oil Reservoir Cover Plate
5042	Filler Cap

ITEM NO.	NAME
1	1/8 – 27 Pipe Plug
2	Junction Bar Bijur 3289
3	Compression Sleeves Bijur 1061
4	Compression Bushing Bijur 1371
5	Meter Units FJD-2 Bijur 3776
6	Compression Sleeve Bijur 3313
7	Compression Nut Bijur 3610
8	Meter Unit FJD-1 Bijur 3775
9	Meter Unit FJD-00 Bijur 3773
10	Straight Adapter "L" = 3/4 Bijur 4312
11	Bijur No. 5B25 5/32 O.D. Brass Tubing 7 – 1/2" Long
12	Straight Adapter L" 5/8 Bijur No. A-2835
13	Houghton "O" Ring S-7-9 or AN 6227-9
14	Tubing Clip, Single B-3570
15	Round Head Scr. – #8 – 32 x 1/4 Long

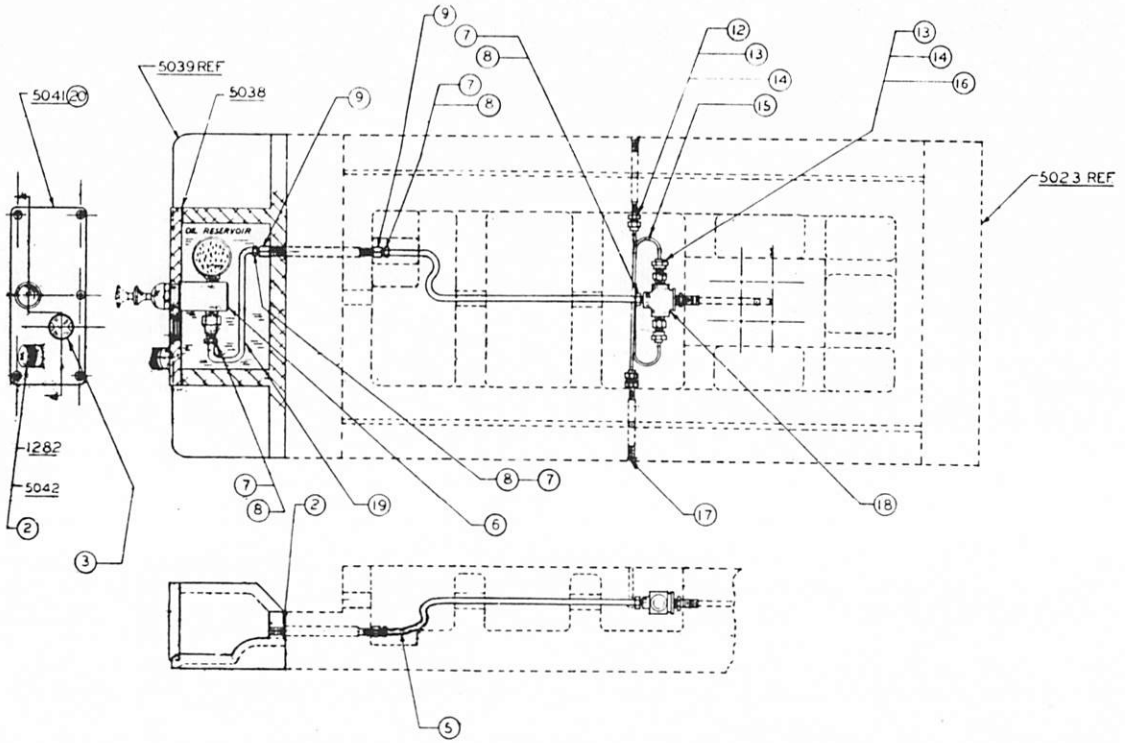
ITEM NO.	NAME
16	Bijur No. 5B25 5/32 O.D. Brass Tubing 6" Long
17	Bijur Lubricator Unit LPM B-6586 (Special)
18	Window-Unit, Std. Type Bijur 4900
19	Bijur No. 3C22 3/32 O.D. Copper Tubing 21" Long
20	Bijur No. 3C22 3/32 O.D. Copper Tubing 14" Long
21	Bijur No. 3C22 3/32 O.D. Copper Tubing 10" Long
22	Bijur No. 3C22 3/32 O.D. Copper Tubing 8" Long
23	Bijur No. 3C22 3/32 O.D. Copper Tubing 7"
25	1/4 – 20 x 1" Long Socket Head Cap Screw
26	10 – 32 x 1/2" Long Socket Head Cap Screw
27	Bijur Straight Adapter B-4452

MODEL 3

TABLE BIJUR LUBRICATING SYSTEM ASSEMBLY

C-5354-A Rev. J

Fig. 47



PART NO.	NAME
1282	Adapter
5038	Gasket
5041	Oil Reservoir Cover Plate
5042	Filler Cap

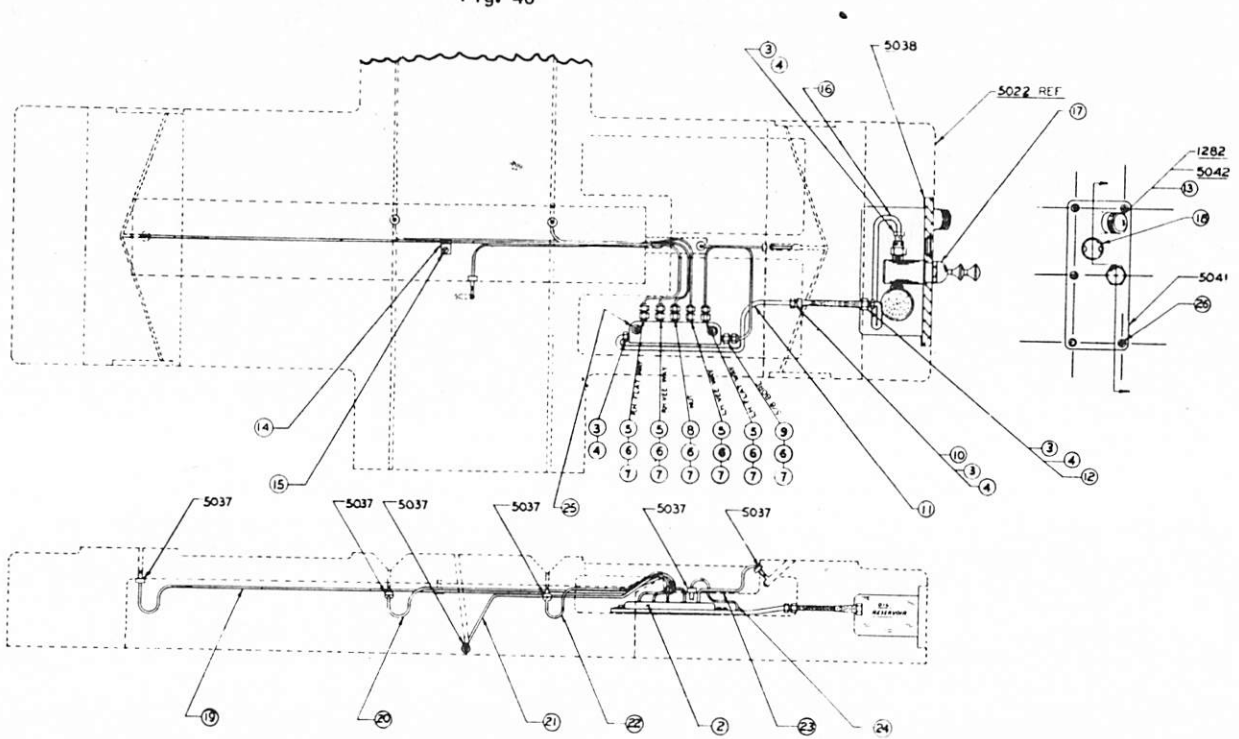
ITEM NO.	NAME
2	E. F. Houghton "O" Ring S-7-9
3	Bijur Window Unit Std. Type B-4900
5	Bijur Brass Tubing No. 5B25 5/32 O.D. 12" Long.
6	Bijur Lubricator Unit L.P.M. B-6586 (Special)
7	Bijur Compression Sleeve B-1061
8	Bijur Compression Bushing B-1371
9	Bijur Straight Adapter B-4312 L" = 3/4
12	Bijur Straight Adapter B-4452
13	Bijur Compression Sleeve B-3313
14	Bijur Compression Nut B-3610
15	Bijur Copper Tubing No. 3C22 3/32 O.D. 5-1/2" Long
16	Bijur Meter-Unit F.J.D.–2 B-3776
17	Tapered Pipe Plug 1/16 – 27
18	Bijur Meter Unit F.T.B.–0, B-1077
19	Bijur Brass Tubing No. 5B25 5/32 O.D. 7" Long.
20	10 – 32 x 1/2 Hex. Sock. Cap Screw

MODEL 3

CROSS SLIDE LUBRICATING SYSTEM ASSEMBLY

D-5352-A Rev. I

Fig. 48

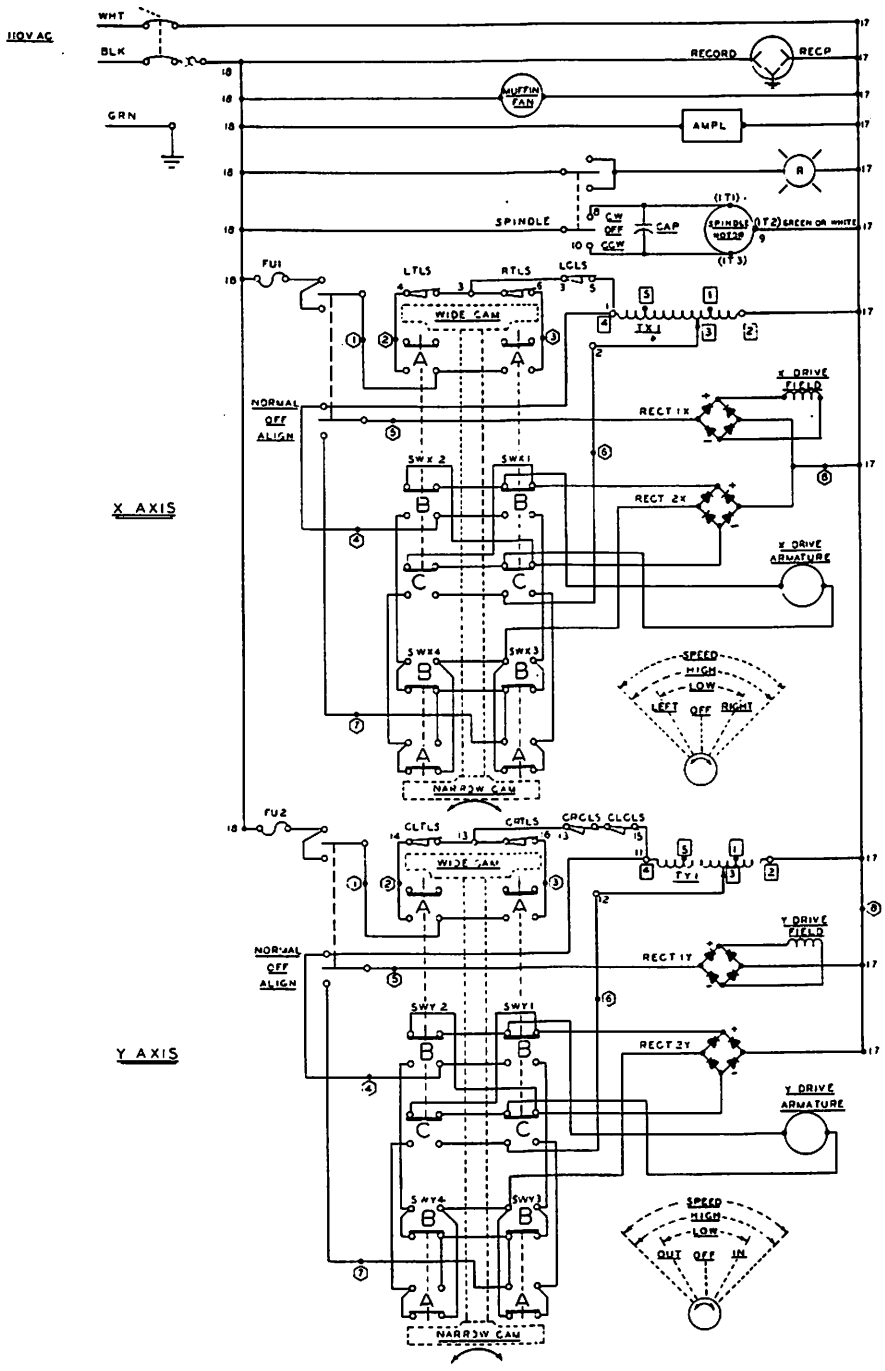


PART NO.	NAME
1282	Adapter
5037	Drive Bushing
5038	Gasket
5041	Oil Reservoir Cover Plate
5042	Filler Cap

ITEM NO.	NAME
2	Junction Bar Bijur 3289
3	Compression Sleeves Bijur 1061
4	Compression Bushing Bijur 1371
5	Meter Units FJD-2 Bijur 3776
6	Compression Sleeve Bijur 3313
7	Compression Nut Bijur 3610
8	Meter Unit FJD-1 Bijur 3775
9	Meter Unit FJD-00 Bijur 3773
10	Straight Adapter L" = 3/4 Bijur 4312
11	Bijur No. 5B25 5/32 O.D. Brass Tubing 10 – 1/2" Long.
12	Straight Adapter L" 5/8 Bijur No. A-2835
13	Houghton "O" Ring S-7-9 or AN 6227-9
14	Tubing Clip, Single B-3570
15	#8 – 32 x 1/4 Long Round Head Scr.
16	Bijur No. 5B25 5/32 O.D. Brass Tubing 6" Long

ITEM NO.	NAME
17	Bijur Lubricator Unit LPM B-6586 (Special)
18	Window-Unit, Std. Type Bijur 4900
19	Bijur No. 3C22 3/32 O.D. Copper Tubing 25" Long
20	Bijur No. 3C22 3/32 O.D. Copper Tubing 14-1/2" Long
21	Bijur No. 3C22 3/32 O.D. Copper Tubing 15" Long
22	Bijur No. 3C22 3/32 O.D. Copper Tubing 9" Long
23	Bijur No. 3C22 3/32 O.D. Copper Tubing 4-1/4" Long
24	Bijur No. 3C22 3/32 O.D. Copper Tubing 8-3/4" Long
25	1/4 – 20 1" Long Socket Head Cap Screw
26	10 – 32 1/2 Long Socket Head Cap Screw

WIRING DIAGRAM ELECTRICAL CONTROLS
(with L. S. Drive)
C-4824 Rev. B
Fig. 49

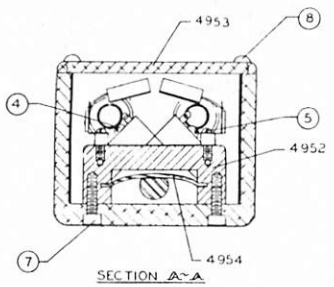


FUSES
L.S. DRIVE
3AG 2A. SLO-BLO
FEDERAL AMPLIFIER
3AG 2/10A. SLO-BLO
CLEVELAND AMPLIFIER
3AG 1A. SLO-BLO

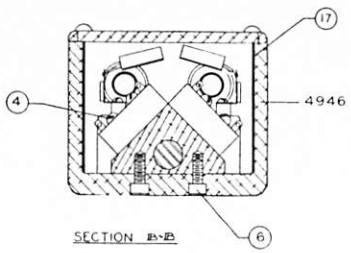
SWITCH SUB-ASSEMBLY

D-4946-SA Rev. F

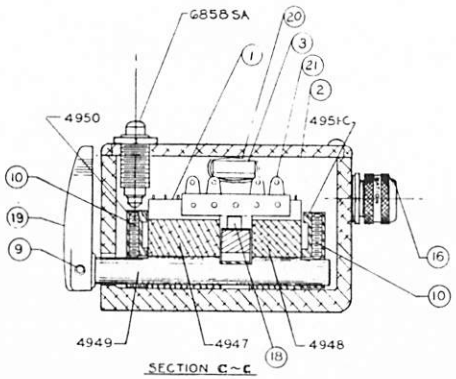
Fig. 50



SECTION A~A



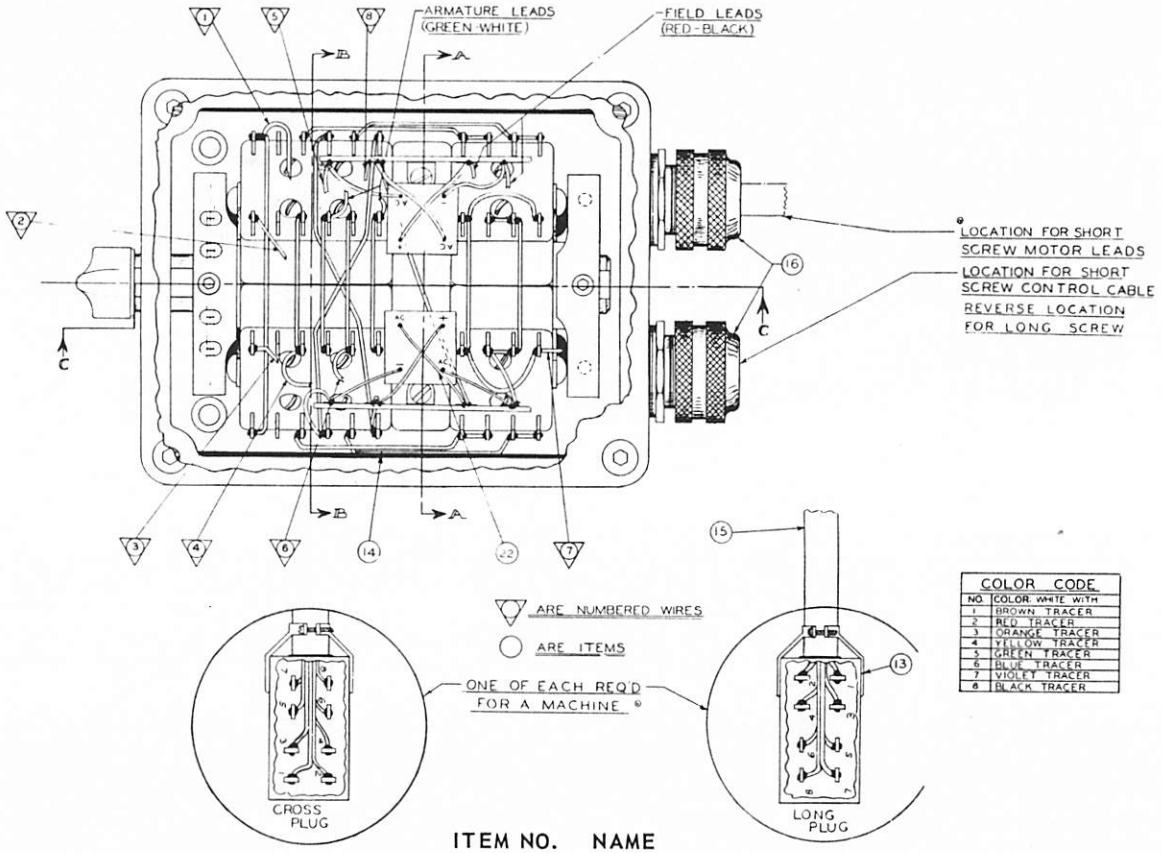
SECTION B~B



SECTION C~C

WIRING NOT SHOWN IN SECTIONS

SCALE-FULL



COLOR CODE	
NO.	COLOR WHITE WITH
1	BROWN TRACER
2	RED TRACER
3	ORANGE TRACER
4	YELLOW TRACER
5	GREEN TRACER
6	BLUE TRACER
7	VIOLET TRACER
8	BLACK TRACER

PART NO.	NAME
4946	Switch Box
4947	Switch Block (Long)
4948	Switch Block (Short)
4949	Switch Shaft
4950	Wide Cam
4951C	Narrow Cam Composite
4952	Spring Holder
4953	Cover
4954	Spring
6858SA	Pushbutton Lock S.A.

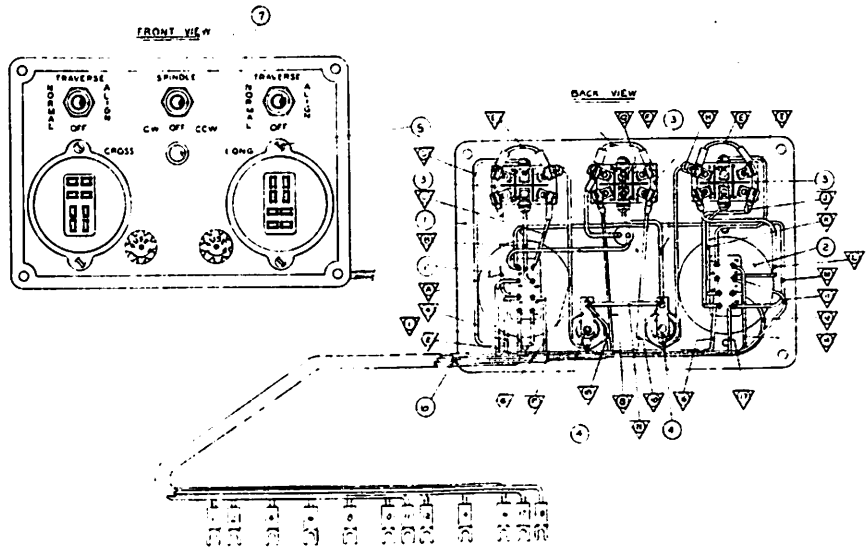
ITEM NO.	NAME
1	Electro-Snap K3-4
2	Electro-Snap D8-4
3	Tarzian Rectifier S-5959-2
4	4 – 40 x 5/8 Round Hd. Screw
5	5 – 40 x 3/8 Round Hd. Screw
6	8 – 32 x 3/8 Sock. Hd. Cap Screw
7	8 – 32 x 1/2 Sock. Hd. Cap Screw
8	8 – 32 x 1/2 Button Hd. Sock. Cap Screw
9	8 – 32 x 1/4 Sock. Set Screw
10	10 – 32 x 3/4 Sock. Set Screw
12	
13	Cinch-Jones Plug #308-CCE
14	#20 Stranded Wire (Jumpers) Cut to Suit
15	Surprenant #BUB 1932N-4946 (Cross-68'', Long-28'')
16	Pyle Straight Cord Grip #DB 3516
17	Fishpaper 3 – 1/4 x 2-1/4
18	H. H. Smith 2100 Spacer
19	#2100 Harry Davies Molding Co., Chicago
20	Alpha PVC105 – 9/16 Clear – 3/4 Lg.
21	Cinch-Jones Lug Type Terminal #548
22	Alpha TFT-200/20 Teflon Tubing

MODEL 1½

TRAVERSE PANEL SUB-ASSEMBLY

C-6822-SA Rev. A

Fig. 51



PART NO.	NAME
6822	Traverse Panel

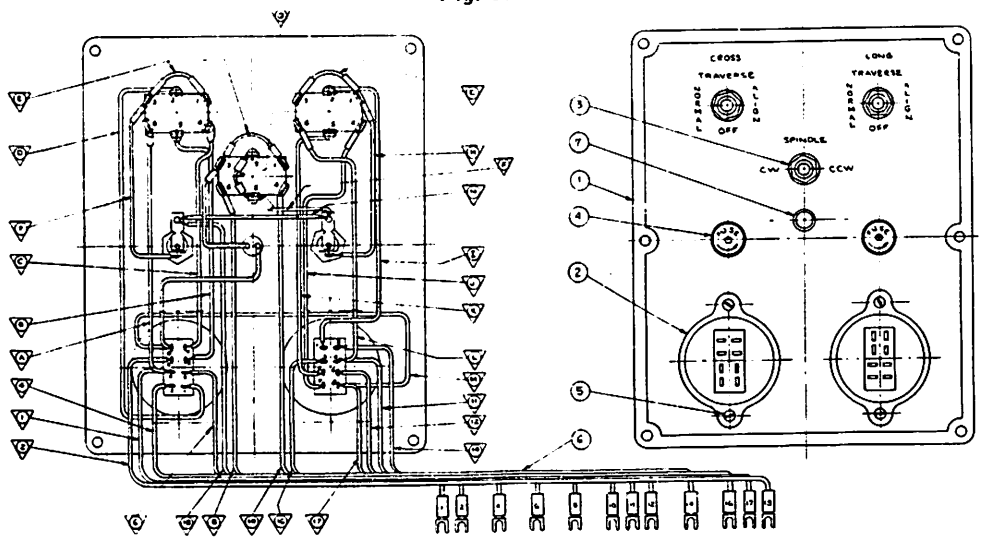
ITEM NO.	NAME
2	Cinch-Jones #S-308RP Socket
3	Micro Switch #12TS1-1 DPDT
4	Little Fuse – #342004 Fuse Holder
5	#5-40 x 1/4 lg. round Hd. Mach. Screw
6	#20 Stranded Wire
7	Drake Ind. Light #6063-634 (Red)

MODEL 3

TRAVERSE PANEL SUB-ASSEMBLY

C-4822-SA Rev. A

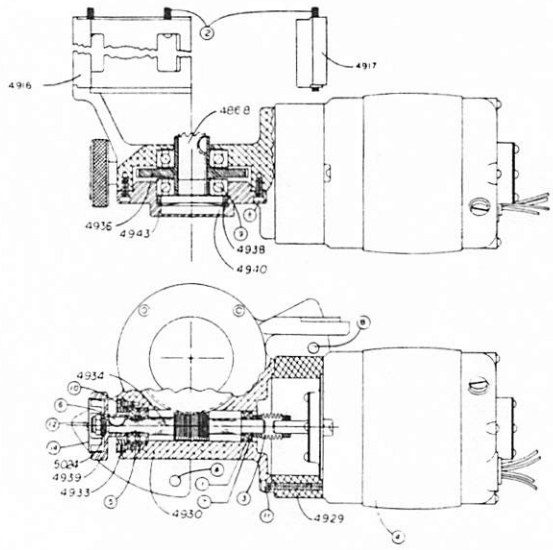
Fig. 52



PART NO.	NAME
4822-SA	Traverse Panel

ITEM NO.	NAME
2	Cinch-Jones #S-308RP Socket
3	Micro Switch #12TS1-1 DPDT
4	Little Fuse – #342004 Fuse Holder
5	#5-40 x 1/4 lg. round Hd. Mach. Screw
6	#20 Stranded Wire
7	Drake Ind. Light #6063-634 (Red)

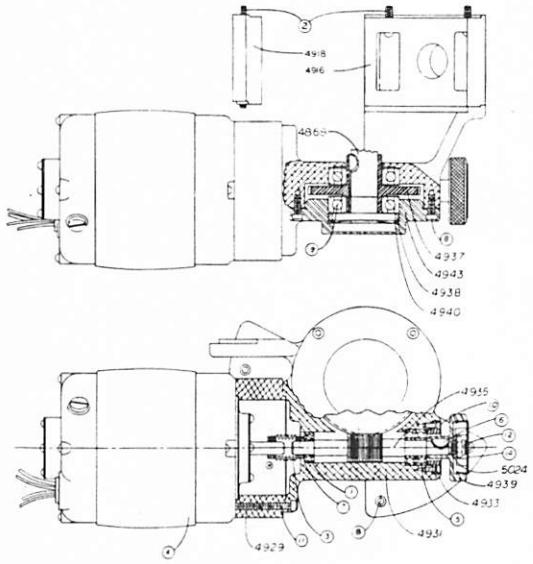
LEAD SCREW DRIVE RH
D-4930-SA Rev. P
Fig. 53



PART NO.	NAME
4868	Thomas Coupling #62 Modified
4916	Spacer Segment
4917	Spacer Segment (R.H.)
4929	Motor Spacer
4930	Housing R.H.
4933	Bearing Cap Knob End
4934	Worm Shaft R.H.
4936	Helical Gear R.H.
4938	Bearing Spacer
4939	Knob
4940	Wavy Spring Washer
4943	Bearing Cap
5024	Washer

ITEM NO.	NAME
1	MRC Bearing No. R-6-ZZ ABEC 3
2	10 – 32 x 3/4 Button Hd. Cap Scr.
3	#FC-9.5 Flexible Coupling S.S. Bellows 3/8 Shaft Size
4	D.C. Motor 1/15 H.P., 115 V, .75 Amp, 1725 RPM (Bodine Electric Co.)
5	MRC Bearing No. 100 KSZZ DB ABEC-3 Light Preload
6	#1 Woodruff Key
7	Waldes Retaining Ring 5101-37
8	#10 – 32 x 1/2 Sock. Hd. Cap Scr.
9	R16-ZZ MRC Bearing
10	#4 – 40 x 3/8 Socket Hd. Cap Scr.
11	#10 – 32 x 2-3/8 Socket Hd. Cap Scr.
12	Esna 21TE-064
13	
14	Button Plug (Carr Co. SS50834)
15	Keystone 44 Grease

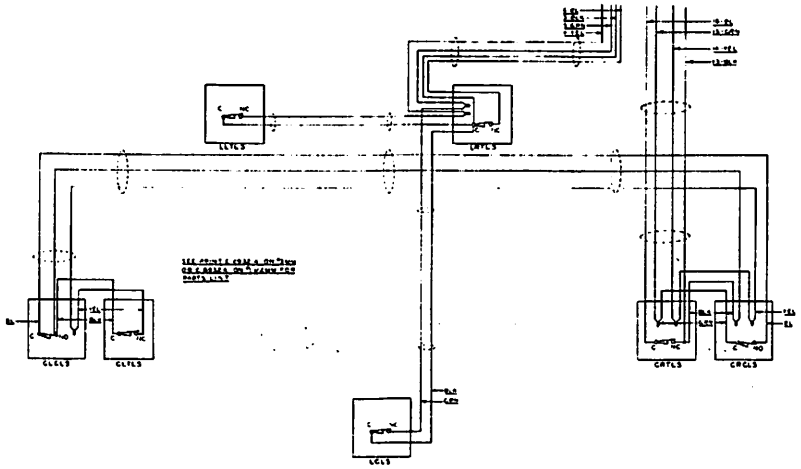
LEAD SCREW DRIVE LH
D-4931-SA Rev. N
Fig.54



PART NO.	NAME
4868	Thomas Coupling #62 Modified
4916	Spacer Segment
4918	Spacer Segment (L.H.)
4929	Motor Spacer
4931	Housing L.H.
4933	Bearing Cap, Knob End
4935	Worm Shaft L.H.
4937	Helical Gear L.H.
4938	Bearing Spacer
4939	Knob
4940	Wavy Spring Washer
4943	Bearing Cap
5024	Washer

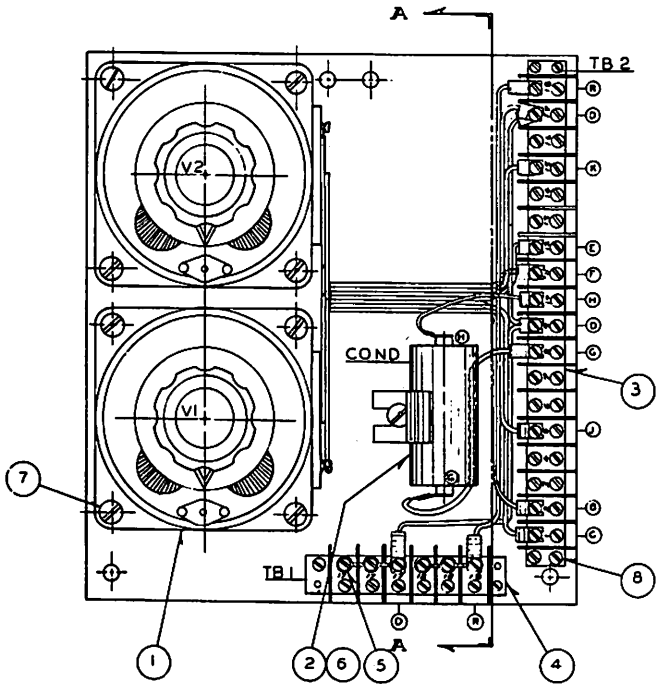
ITEM NO.	NAME
1	MRC Bearing No. R-6-ZZ ABEC 3
2	10 – 32 x 3/4 Button Hd. Cap Scr.
3	#FC-9.5 Flexible Coupling S.S. Bellows 3/8 Shaft Size
4	D.C. Motor 1/15 H.P., 115 V, .75 Amp., 1725 RPM (Bodine Electric Co.)
5	MRC Bearing No. 100 KSZZ DB ABEC-3 Light Preload
6	#1 Woodruff Key
7	Waldes Retaining Ring 5101-37
8	#10 – 32 x 1/2 Sock. Hd. Cap Scr.
9	R16-ZZ MRC Bearing
10	#4 – 40 x 3/8 Socket Hd. Cap Scr.
11	#10 – 32 x 2-3/8 Socket Hd. Cap Scr.
12	Esna 21TE-064
13	
14	Button Plug (Carr Co. SS50834)
15	Keystone 44 Grease

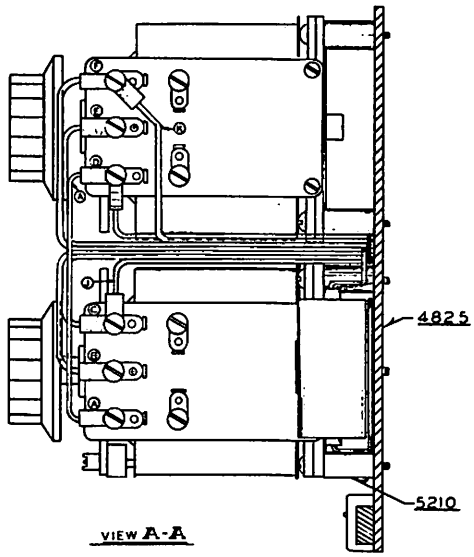
LIMIT & CLAMP SWITCHES
C-6919
Fig. 55



CLCLS	Cross left clamp limit switch	CRTLS	Cross right travel limit switch
CLTLS	Cross left travel limit switch	CRCLS	Cross right clamp limit switch
LLTLS	Longitudinal left travel limit switch	LCLS	Longitudinal clamp limit switch
LRTLS	Longitudinal right travel limit switch		

DRIVE PANEL SUB-ASSEMBLY
C-4925-SA Rev. A
Fig. 56





PART NO.	NAME
4825	Drive Panel
5210	Spacer

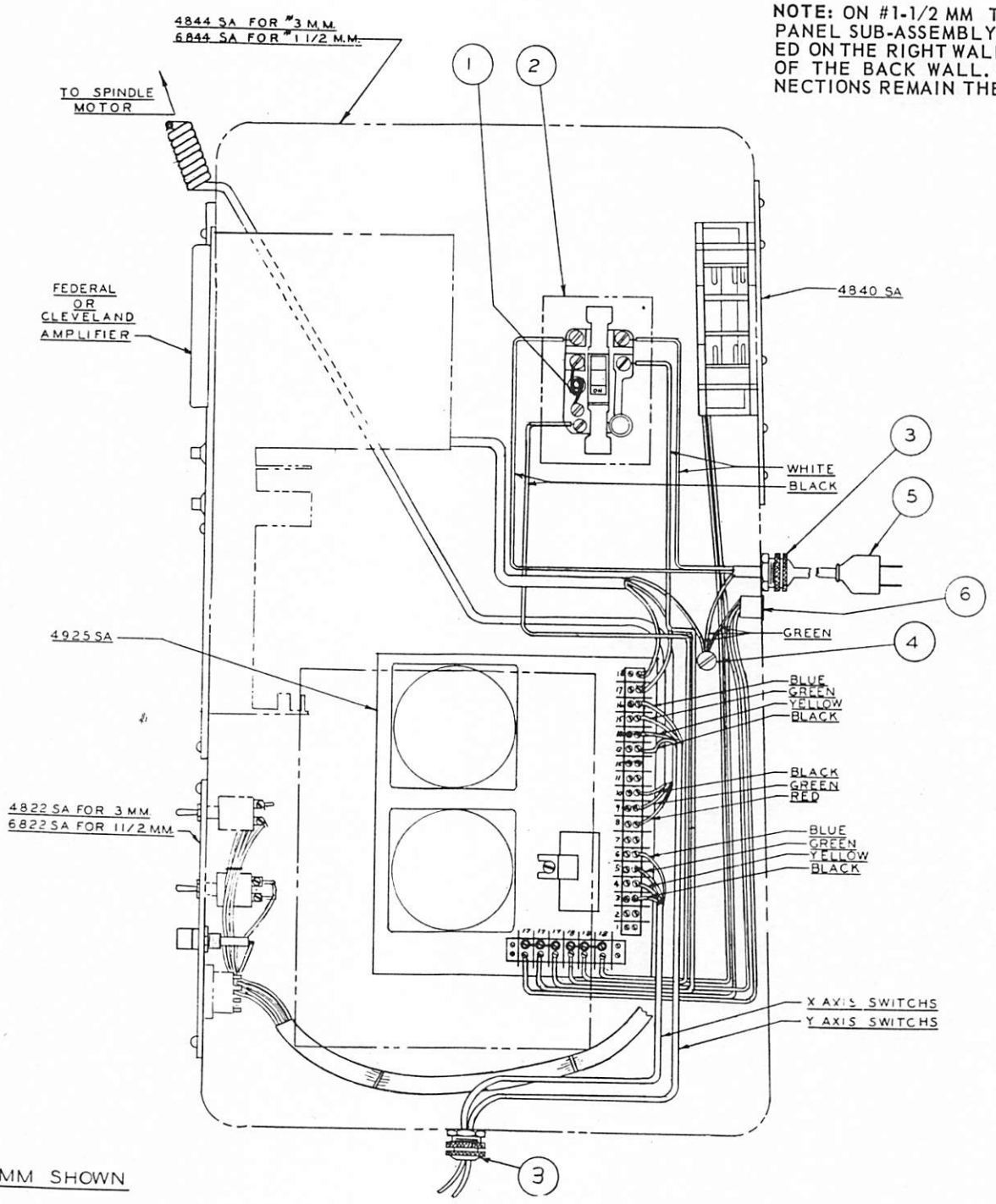
ITEM NO.	NAME
1	Gen. Radio Co. Type W2 Variac
2	Capacitor Supplied with motor
3	Cinch-Jones Terminal Strip #18-140
4	Cinch-Jones Terminal Strip #6-140
5	Cinch-Jones Jumpers #141J
6	#10 – 32 x 1/4 Binding Head Screw
7	10 – 32 x 1-1/4 Round Head Screw
8	5 – 40 x 3/8 Round Head Screw

ELECTRICAL INSTALLATION

C-4828-A Rev. E

Fig. 57

NOTE: ON #1-1/2 MM THE DRIVE PANEL SUB-ASSEMBLY IS MOUNTED ON THE RIGHT WALL INSTEAD OF THE BACK WALL. WIRE CONNECTIONS REMAIN THE SAME.



*3 MM SHOWN

PART NO.	NAME
4925SA	Drive Panel Sub Assembly
4840SA	Fan Sub Assembly

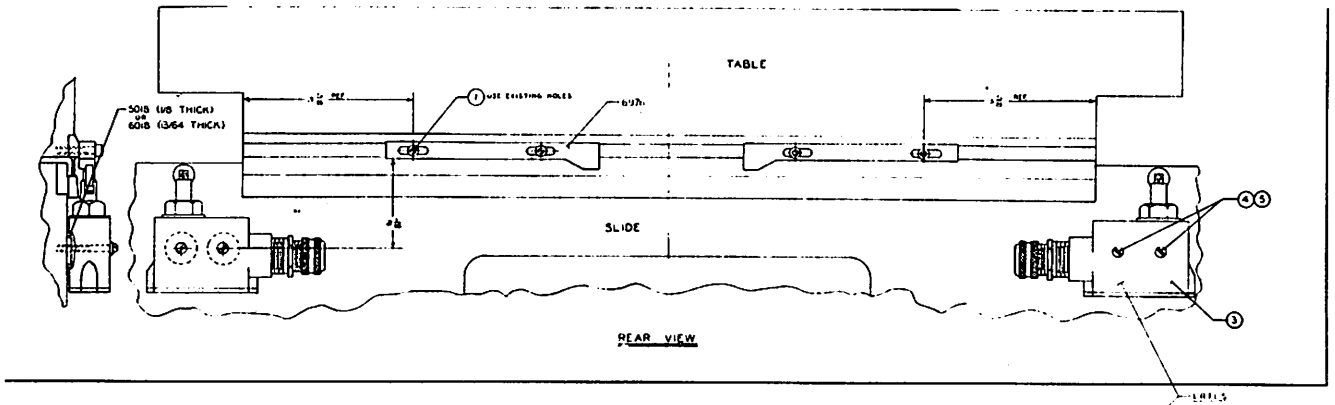
ITEM NO.	NAME
1	Heater Element, Allen-Brad. Bul. 600 – Type P-26
2	Switch, Allen-Brad. Bul. 600 Form 52
3	DB-3516 Pyle National Cord Grip
4	#8 – 32 x 3/8 Binding Head Screw
5	6 Ft. Cord, 3/18 SJO with Molded Plug
6	XLR-3-13 Receptacle – Cannon

MODEL 1½

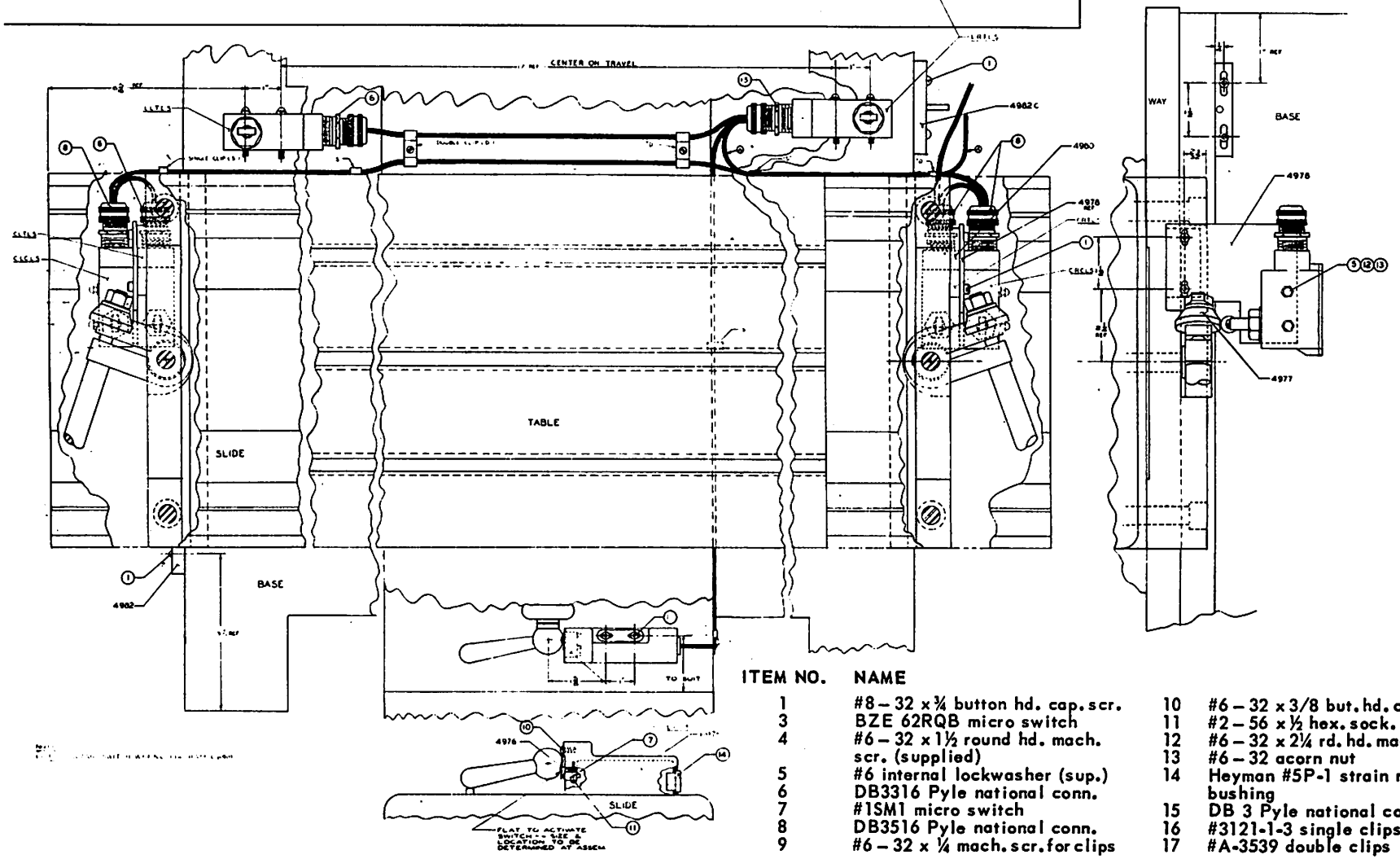
POWER FEED CONTROL INSTALLATION

E-6932-A Rev. E

Fig. 58



PART NO.	NAME
4976	Actuator spring
4977	Clamp cam
4978	Switch plate
4980	Spacer
4982C	Cross cam composite
5018 or 6018	Spacer
6975	Limit switch housing
6976	Long cam



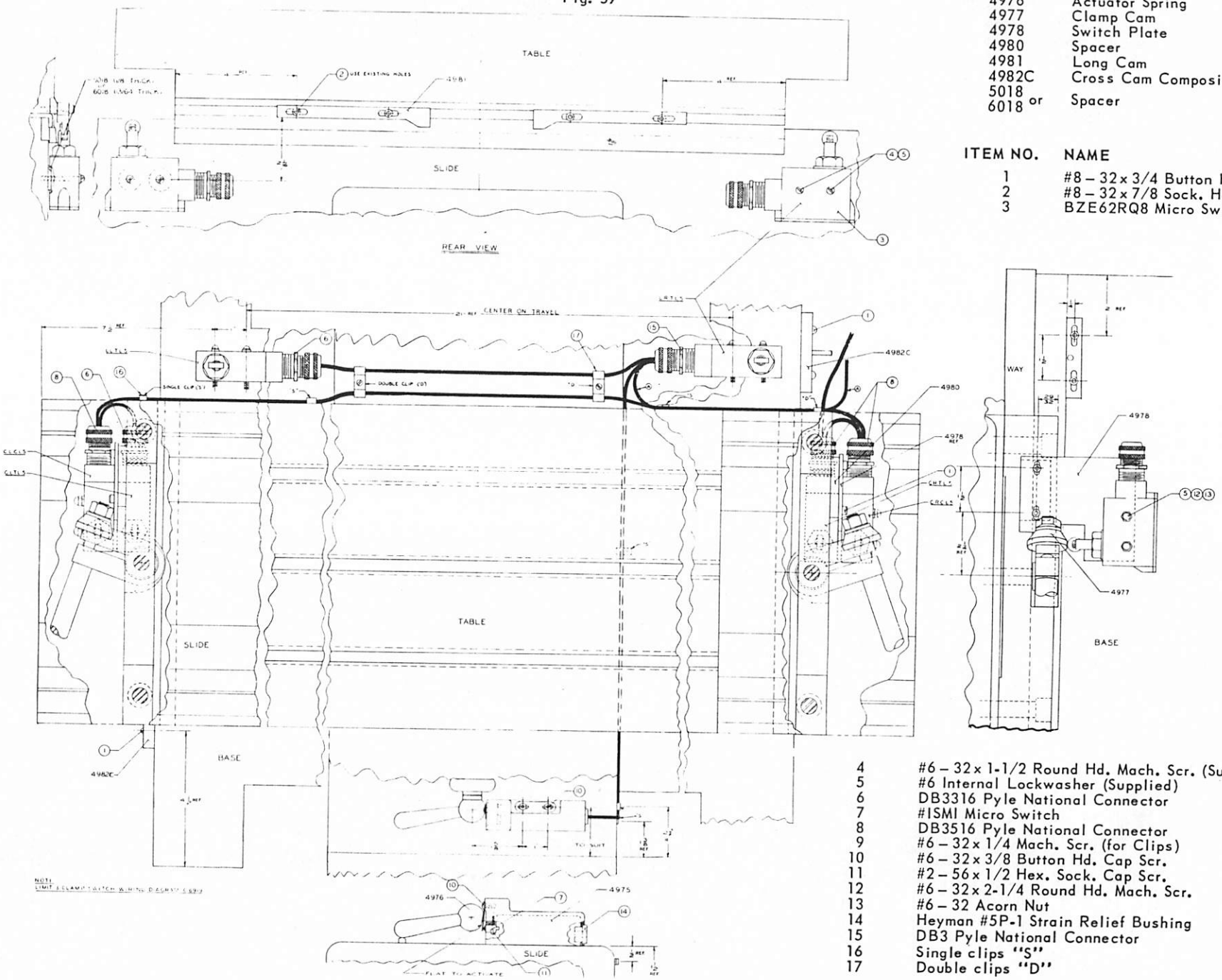
ITEM NO.	NAME	ITEM NO.	NAME
1	#8 – 32 x ¾ button hd. cap. scr.	10	#6 – 32 x 3/8 but. hd. cap scr.
3	BZE 62RQB micro switch	11	#2 – 56 x ½ hex. sock. cap scr.
4	#6 – 32 x 1½ round hd. mach. scr. (supplied)	12	#6 – 32 x 2¼ rd. hd. mach. scr.
5	#6 internal lockwasher (sup.)	13	#6 – 32 acorn nut
6	DB3316 Pyle national conn.	14	Heyman #5P-1 strain relief bushing
7	#1SM1 micro switch	15	DB 3 Pyle national conn.
8	DB3516 Pyle national conn.	16	#3121-1-3 single clips "S"
9	#6 – 32 x ¼ mach. scr. for clips	17	#A-3539 double clips "D"

MODEL 3

POWER FEED CONTROL INSTALLATION

E-4932-A Rev. D

Fig. 59



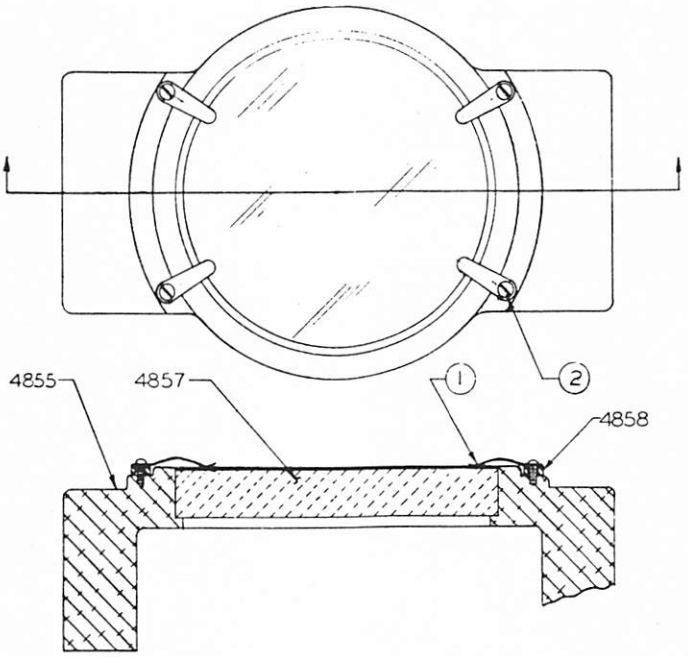
PART NO.	NAME
4975	Limit Switch Housing
4976	Actuator Spring
4977	Clamp Cam
4978	Switch Plate
4980	Spacer
4981	Long Cam
4982C	Cross Cam Composite
5018 or 6018	Spacer

ITEM NO.	NAME
1	#8 – 32 x 3/4 Button Hd. Cap Scr.
2	#8 – 32 x 7/8 Sock. Hd. Cap Scr.
3	BZE62RQ8 Micro Switch
4	#6 – 32 x 1-1/2 Round Hd. Mach. Scr. (Supplied)
5	#6 Internal Lockwasher (Supplied)
6	DB3316 Pyle National Connector
7	#ISMI Micro Switch
8	DB3516 Pyle National Connector
9	#6 – 32 x 1/4 Mach. Scr. (for Clips)
10	#6 – 32 x 3/8 Button Hd. Cap Scr.
11	#2 – 56 x 1/2 Hex. Sock. Cap Scr.
12	#6 – 32 x 2-1/4 Round Hd. Mach. Scr.
13	#6 – 32 Acorn Nut
14	Heyman #5P-1 Strain Relief Bushing
15	DB3 Pyle National Connector
16	Single clips "S"
17	Double clips "D"

TRANSPARENT STAGE ASSEMBLY

B-4855-A

Fig. 60



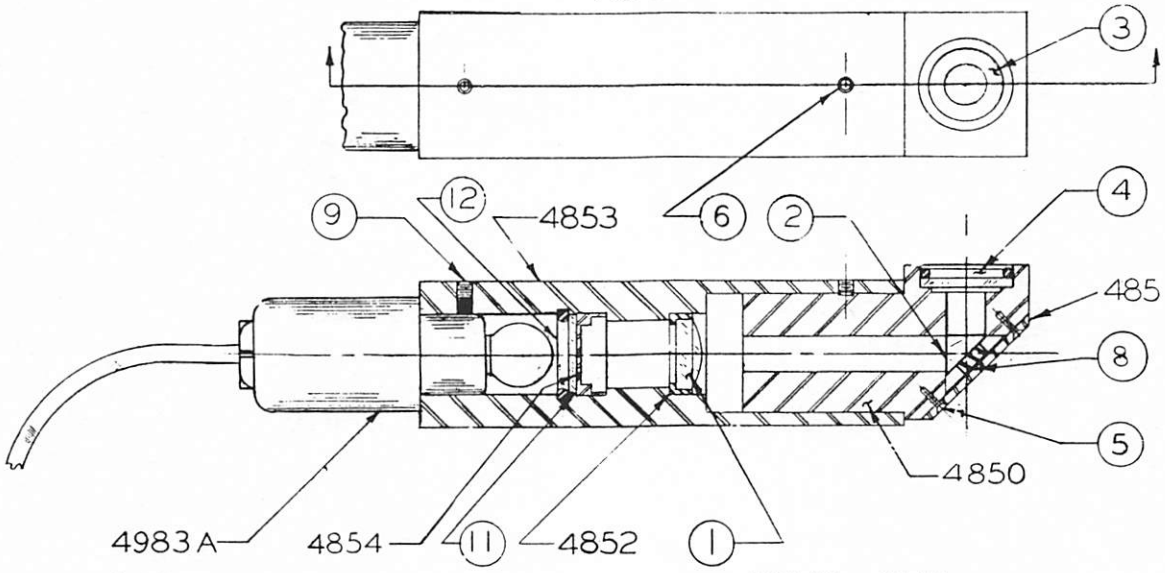
PART NO.	NAME
4855	Transparent Stage
4857	Inspection Optic
4858	Spacer

ITEM NO.	NAME
1	Finger Spring ALSCO A-2
2	#6 – 32 x 3/8 Round Hd. Screw

COLLIMATED LIGHT ASSEMBLY

B-4854-A Rev. J

Fig. 61



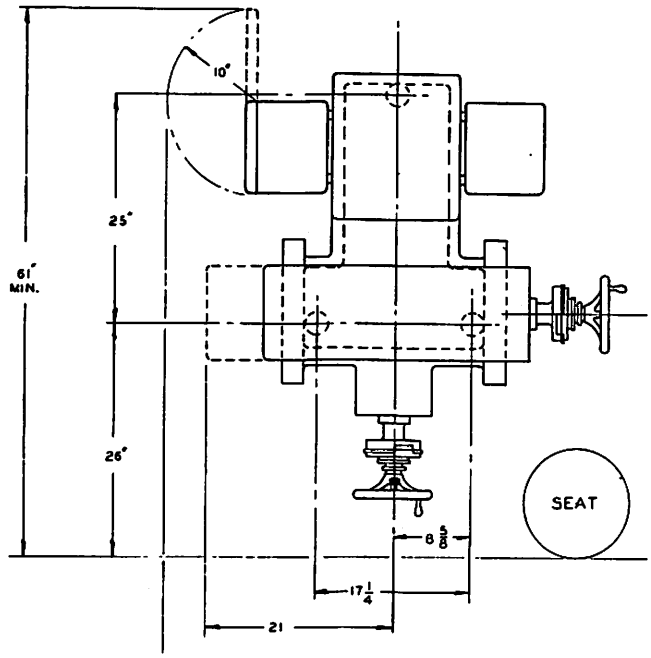
PART NO.	NAME
4850	Prism Holder
4851	Prism Holder Cover
4852	Lens Retainer
4853	Collimator Body
4854	Light Restrictor
4983A	Illuminator Assembly

ITEM NO.	NAME
1	Lens – Bauch & Lomb No. 81-61-01-023
2	3/8 Right Angle Prism, Bauch & Lomb – No. 31-90-01-013
3	Filter – Tiffen Optical Co. Blue-Green
4	"O" Ring No. S-7-12
5	#2-56 x 1/4 Flat Hd. Screw
6	#5 – 40 x 1/8 Set Screw Flat Pt.
8	Neoprene Pads (to hold Prism Snug)
9	#5 – 40 x 1/4 Sock. Set Screw (Nylon End Pellet) Special 94 series
11	Filter – Tiffen Optical Co. – Frosted
12	"O" Ring S-7-11

FLOOR PLAN LAYOUT

MODEL 1½

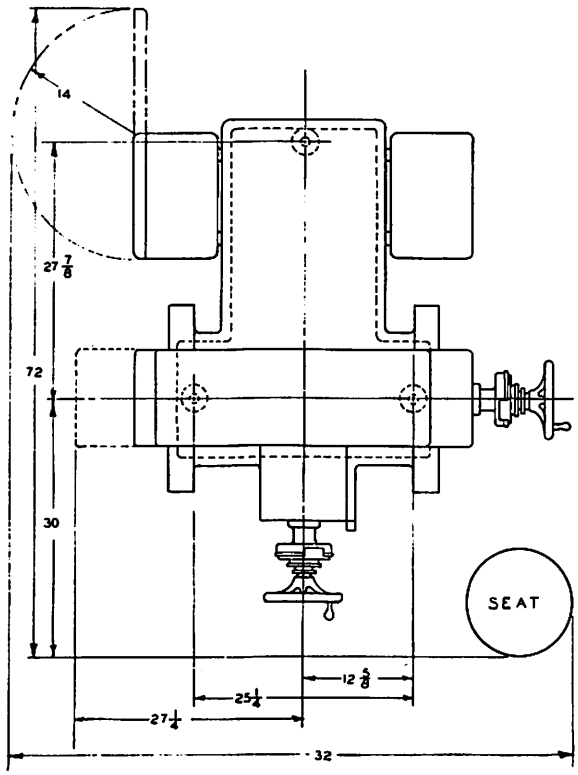
Fig. 62



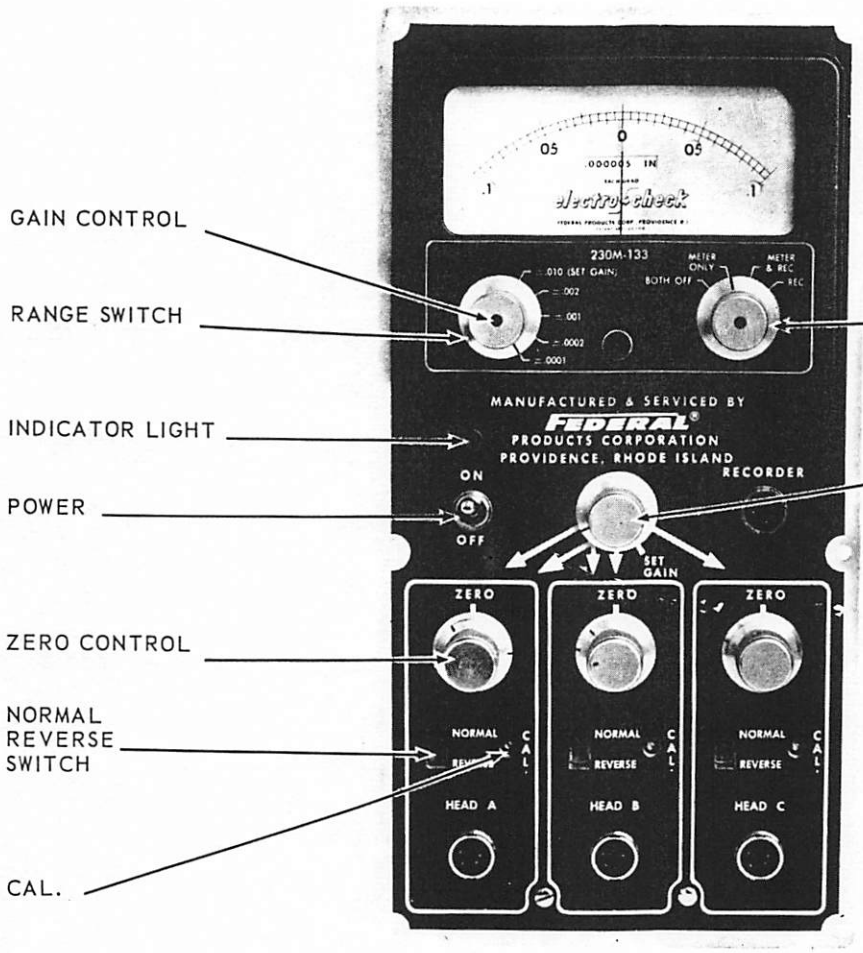
FLOOR PLAN LAYOUT

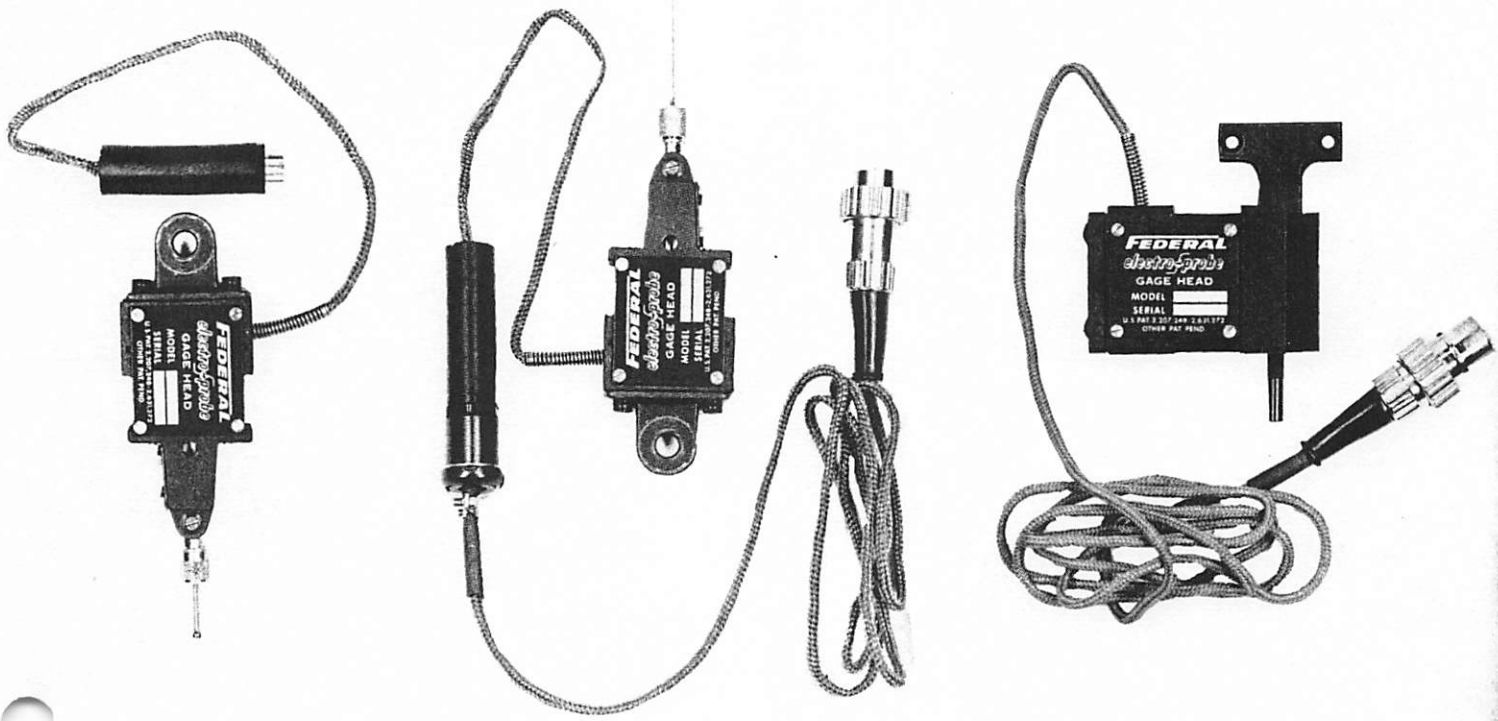
MODEL 3

Fig. 63



FEDERAL AMPLIFIER
Fig. 64





HEAD A HEAD B HEAD C

INSTRUCTIONS FOR ALIGNMENT AND CALIBRATION OF FEDERAL AMPLIFIER

EQUIPMENT

One (1) transistorized Model 230M Amplifier mounted on a panel designed to fit in control cabinet of Moore Measuring Machine.

Three (3) electronic gage heads designated as heads A, B, and C.

1. Head "A" is supplied with four (4) swivel style contacts:
   1 – extra long with a 1/16" dia. ball
   3 – standard with different ball sizes:
   1/8", 1/16", and 1/32" dia.

2. Head "B" is with a regular swivel contact and an extra .031 ball contact, regular length.

3. Head "C" is a reed style gage head.

ELECTRICAL SETUP

1. Turn "power switch" to ON, and a light above the switch should go on.

2. Turn the "head selector switch" in the center of the panel to SET GAIN.

3. Turn the "range switch" below the meter to .010 which is SET GAIN.

4. Turn the "meter recorder switch" to METER ONLY.

5. The meter hand should move full scale on the dial to within plus or minus one graduation of the end of the scale. If it does not, make any necessary adjustment by inserting a long thin screwdriver in the hole in the center of the "range switch" and bring the hand of the meter to the exact end of the scale.

6. Connect gage heads "A", "B", and "C" to their appropriate connectors located on the front of the panel. Mount the heads to the appropriate holders on the machine.

7. Turn the "range switch" to ± .010.

8. Any of the three heads can be used for the initial calibrations, however, for illustration start with gage head "A" and turn the "head selector switch" to HEAD "A" singly.

9. Turn the "zero control" of gage HEAD "A" to mid-range position.

10. Slide the "NORMAL-REVERSE switch" to the NORMAL position.

11. Place a "Moore Pick-Up Block" or a reference block on the table. Using head "A" which is mounted to the spindle nose, bring the probe into contact with the piece. Zero the meter using the leadscrew.

12. Advance the leadscrew +.010 from the meter zero position, reading the displacement from the leadscrew dial. Note reading on meter. Retract the leadscrew and advance it to a reading of –.010 from the meter zero position, reading the displacement from the leadscrew. Adjust "HEAD A CAL." so that any errors are equal at either end of the scale. (This is a screwdriver adjustment next to the slide switch.) When switching to different scales a slight adjustment may be necessary.

13. If the entire range of the head is short – or long – make a compensating adjustment of the "gain control" through the hole in the center of the "range switch."

14. Turn the "head selector switch" to HEAD "B", singly, and set "zero control" of head "B" to mid-range position. Slide switch should be in NORMAL position.

15. Repeat steps 11 and 12 above to complete the electrical adjustment for head "B". (Do not touch "gain control".)

16. Turn the "selector switch" to "HEAD C" and set "zero control" of "HEAD C" to mid-range position. Select three gage block combinations which differ from each other by .010. Repeat steps 11 and 12 using the gage blocks instead of the leadscrew for calibrating head "C". (Do not touch "gain control.")

NOTE: In calibrating heads "B" and "C" you do not touch "gain control", because initially you have matched the amplifier to head "A" and then in turn you have matched heads "B" and "C" to the amplifier so that all the heads operate alike electrically.

17. Two of the heads, "A" and "B" can be operated differentially, adding or subtracting through the use of "NORMAL-REVERSE switches" to change the phase.

18. Placing the "NORMAL-REVERSE switch" to REVERSE changes the polarity of the head output. By turning the "head selector switch" to A & B places head A in the circuit in series with head B and can add or subtract differentially depending on the position of the "NORMAL-REVERSE switch". Also, head "B" is now in the circuit with head "A" and can add or subtract differentially depending on the position of the "NORMAL-REVERSE switch."

THEORY OF OPERATION

1. The meter has five different magnifications on a click scale.

RANGE	VALUE OF EACH GRADUATION (Inches)
± .0001	5 millionths
± .0002	10 millionths
± .001	.00005
± .002	.0001
± .010	.0005

METRIC RANGES AND GRADUATIONS – MICRONS

RANGE	VALUE OF EACH GRADUATION
± 2	.1 microns
± 4	.2 microns
± 20	1 microns
± 40	2 microns
± 200	10 microns

2. This transistorized amplifier is capable of accepting three gage heads.

3. The amplifier is also capable of operating a recorder and a meter simultaneously.

4. Output for recorder is 500-0-500 micro-amps.

5. With the Selector Switch in first position, Head "A" is in the circuit singly, and may be connected to the spindle of the Moore Machine with a rotary joint connection similar to a rotary commutator and used as a polar coordinate. The meter hand can be made to read either right or left on the dial depending on the position of the slide switch, NORMAL or REVERSE.

NOTE: Gage Heads "A" and "B" contacts can be pivoted about their nosepiece pivots for various setups approximately 180° without change of magnification. However, the contacts for gage Head "A" have a second pivot point between gage head nosepiece and the end of the contact.

This pivot is a safety feature only. It operates 90° to the normal motion of gage contact and is intended to avoid gage head and/or contact damage only.

It is absolutely essential that the swivel style contact be used in a straight out position.

Pivoting the contact about this second pivot shortens the effective length of the contact and, therefore, changes gage head magnification.

6. Head "A" can also be disconnected from the machine spindle and used with an extension cable as an accessory for rectilinear coordinates. Here, again, you must remember that this two-position double swivel wiggle stick can only be used with the contact pivot in a straight out position to obtain the correct meter reading.

   The longer contact supplied with the gage is actually twice the normal length and, therefore, will show on the meter only half its linear displacement.

7. With Selector Switch in second position, Head "B" is in the circuit differentially either adding or subtracting, depending on the position of NORMAL-REVERSE slide switch.

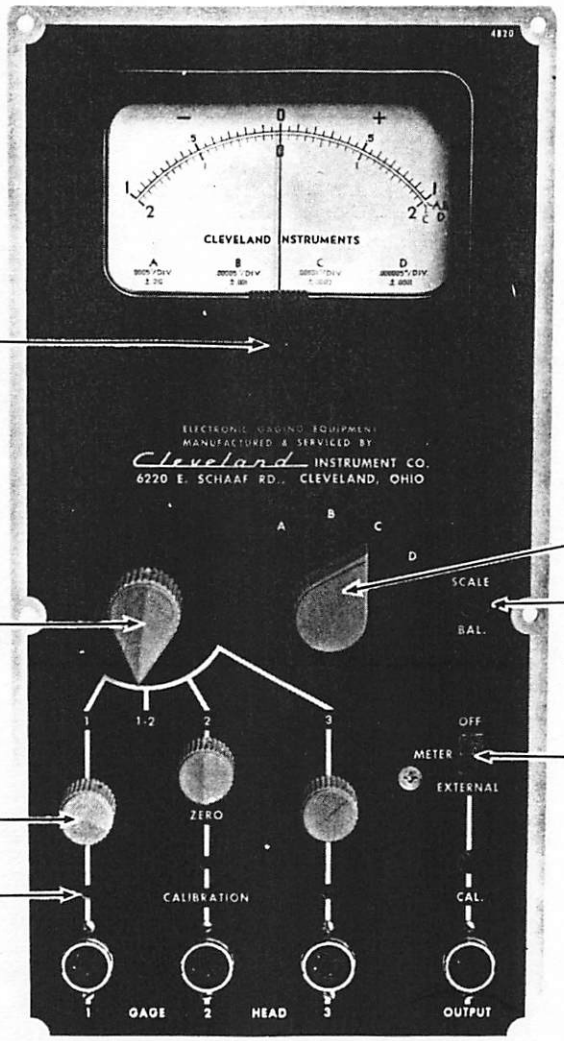
8. With Selector Switch in third position, Head "B" is in the circuit singly.

9. Fourth position is SET GAIN already described above.

10. Fifth position brings Head "C" into the circuit singly. Head "C" is a reed style gage head and is intended to be used to measure vertical motion of the spindle in Z axis.

NOTES

CLEVELAND AMPLIFIER
Fig. 65



SCREW DRIVER CONTROL

HEAD SELECTOR

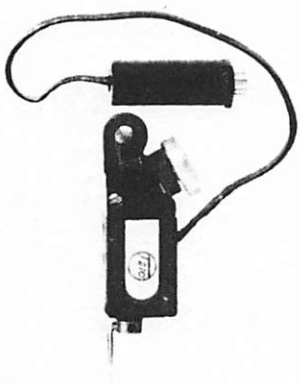
ZERO CONTROL

CALIBRATION

RANGE SELECTOR

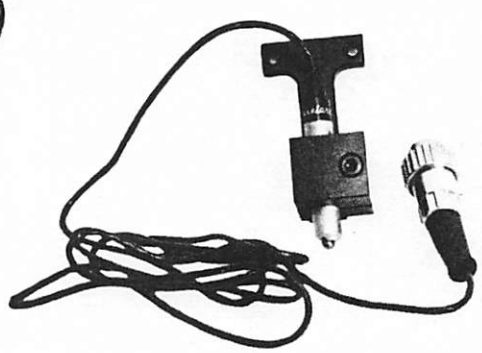
SCALE BALANCE

OFF - METER - EXTERNAL



HEAD 1

HEAD 2



HEAD 3

MOORE TOOLS

INSTRUCTIONS FOR ALIGNMENT AND CALIBRATION OF CLEVELAND AMPLIFIER

SCALE ZERO ALIGNMENT

To accurately transfer readings from one scale range to another, it is necessary that the meter zero points coincide on all scales. This can be checked as follows:

1. With the "OFF-METER-EXTERNAL switch" in the EXTERNAL position the meter should read zero. If necessary, adjust the "screwdriver control" on the face of the meter until the meter reads zero.

2. Initial switch settings:

   "OFF-METER-EXTERNAL" on METER
   "range selector" on "D" range
   "head selector" on "1"

   The gage heads should not be connected.
   Turn the "zero control" of head 1 so that the meter reads zero.
   Change the "head selector" to head 2 and zero the meter.
   Change to head 3 and zero meter.

3. With the "head selector" in the "1" position, switch the "range selector" to the "C", "B", and "A" ranges. The meter pointer should remain at the zero position. If there is a change in the meter reading, proceed as follows:

   A. Remove screws holding the side panel on the R.H. Control Box. Located just below the amplifier panel the zero balance trimpot is visible for adjustment.

   B. Turn the "range selector" to the "D" range and adjust the "zero control" until the meter reads zero.

   C. Turn the "range selector" to the "A" range position. Adjust the "zero balance trimpot" – located at the bottom of the circuit board below the tubes – until the meter reads zero.

Repeat step B and C if necessary.

CALIBRATION ADJUSTMENT

Before this adjustment can be properly done, the SCALE ZERO ALIGNMENT must be checked first and aligned if necessary.

The calibration of the amplifier should be checked periodically and adjusted if necessary.

Connect gage heads "1", "2" and "3" to their appropriate connectors located on the front of the panel. Mount the gage heads to their appropriate holders on the machine.

1. Any of the three heads can be used for the initial calibrations, however, for illustration, start with gage head "1" and turn the "head selector" to "1".

2. Place a "Moore Pick-Up Block" or a reference block on the table. Using head 1 which is mounted to the spindle nose, bring the probe into contact with the block. Zero the meter by using the leadscrew.

3. The "range selector" should be in "B" range, ±.001. Advance the leadscrew +.001 from the meter zero position reading the displacement from the leadscrew dial. If calibration is correct, the meter will now read exactly full scale +.001.

4. If not, use a screwdriver to turn the slotted shaft of the "CALIBRATION" adjustment until the meter reads exactly full scale, +.001.

All four scales are electrically coupled so that this calibration holds for all ranges.

Repeat steps 1 – 4 to calibrate head 2.

To calibrate head #3 – the reed style gage head – turn the "head selector" to "3". Select two sets of gage block combinations which differ from each other by .001, for example 2.200 and 2.201. Place the 2.200 block combination on the lapped platen directly below the gage head. Lower the quill so that the meter reads approximately zero. Use the zero control for final zeroing. Lock the quill. Replace the gage blocks with the 2.201 combination. The meter will now read exactly full scale +.001. If not, refer to step 4 for adjustment.

Scale Balance Control

1. Follow the procedure for calibrating the amplifier.

2. Using the leadscrew and range selector switch set on "B" range, bring meter hand to zero.

   Advance leadscrew +.001 note meter reading. Retract leadscrew –.001 from zero and note reading. The meter hand should move equal amounts on both sides of zero. If not, adjust scale balance by turning adjusting screw 1/2 the distance of error.

3. Repeat procedure starting with Step 1, and re-adjust calibration if necessary. Normally only one adjustment is required.

Fuse or Pilot Light Replacement

To replace either the pilot light or fuse, remove amplifier from control box.

The fuse is a standard type 3 AG, 1 ampere Slo-Blo, cartridge type fuse and is located on top of the chassis. Do not use any fuse of greater than 1 ampere capacity.

The pilot light is a 1775 6.3 volt miniature screw base type light and is located at the rear of the off meter external switch.

Tube Replacement

This amplifier uses standard radio tubes, and normal tube life is more than two years of daily operation.

The Cleveland amplifier requires specially selected tubes for best results. We recommend that you get your replacements from:

Cleveland Instrument Plant
Micrometrical Division
Bendix Corporation
Cleveland, Ohio

To replace tubes, remove amplifier from control box.

Three tubes are used, a 6CG7 and two 12AX7. When replacing the 6CG7 tube, it is necessary to re-adjust the scale balance control.

Differential Calibration of the AGD Amplifier

There are several methods of calibrating the amplifier for differential usage. One method is to calibrate head #2 by the same procedure used for head #1, but with the "head selector" switch in the Head #2 position.

The best method, however, is to mount a part in the actual fixture and calibrate in the following manner:

1. With the part in position, the "head selector" switch in #1 position and the "range selector" switch on "A", bring the indicator probe in contact with the work piece by moving the leadscrew until the meter reads zero.

2. Set the "head selector" switch to the #2 position. Adjust the #2 gage head with the "Fine Adjustment" on the gage head until the meter reads zero.

3. Set the "range selector" switch to the "C" range and reset the meter to read zero with the "zero controls" for both heads.

4. While in the "C" range it should be possible to move the leadscrew .003" in either direction from zero without deflecting the meter needle more than 1/2 a division.

5. If the deflection amounts to more than 1/2 a division, adjust the "calibration" control under head #2 until the requirements in step #4 are satisfied.

The AGD Amplifier is now calibrated and the two gage heads are matched for use as a "Differential System".

Moore Tool Company

P.O. Box 4088
800 Union Avenue
Bridgeport, CT 06607-0088
Tel (203) 366-3224
Fax (203) 367-0418

To: All Moore Measuring Machine users.
From: Moore Tool Service Department
Ref: Lubrication requirements

Due to the obsolescence of Sunoco way oils we are offering the following lubrication recommendations. These are based on years of experience with the nearly identical Jig borers and Jig Grinder machine lines.

80133-G (gallon) Mobil Vacuoline 1409 This is recommended for all leadscrew cavities and machine ways roller and plane bearing.
36754-PT (pint) Mobil Velocite 6 This is recommended for all quill lubrication.

Options:
80130-G (gallon) Mobil Vactra #2 Plane way heavy loading any place that Sunoco 80 was recommended.
80565-G (gallon) Mobil Vacuoline 1405 This is slightly lighter than 1409 and can be used in all leadscrew cavities and ways